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COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF ENVIRONMENTAL PROTECTION

CHARLES RIVER WATERSHED
1997/1998 WATER QUALITY
ASSESSMENT REPORT

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CHARLES RIVER WATERSHED

1997/1998 WATER QUALITY ASSESSMENT REPORT

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Department of Environmental Protection

Division of Watershed Management

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DIVISION OF WATERSHED MANAGEMENT
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LIST OF ACRONYMS

7Q10	Seven Day Ten Year Low Flow
ACEC	Areas of Critical Environmental Concern
BMP	Best Management Practice
BPJ	Best Professional Judgement
CFS	Cubic Feet per Second
CMR	Code of Massachusetts Regulations
CNOEC	Chronic No Observed Effect Concentration
CWA	Clean Water Act
DDT	Dichlordiphenyltrichloroethane
DEM	Department of Environmental Management
DEP	Department of Environmental Protection
DFWELE	Department of Fisheries, Wildlife, and Environmental Law Enforcement
DMR	Discharge Monitoring Report
DO	Dissolved Oxygen
DPH	Massachusetts Department of Public Health
DWM	Department of Watershed Management
EPA	United States Environmental Protection Agency
GIS (MassGIS)	Geographic Information System
GP	Gravel Packed
GPM (D)	Gallons Per Minute (Day)
JTU	Jackson Turbidity Unit
LC_{50}	Lethal Concentration to 50% of the Test Organisms
MDC	Metropolitan District Commission
MEPA	Massachusetts Environmental Policy Act Unit
MGD	Million Gallons per Day
mg/L	Milligram per Liter
NCCW	Non-Contact Cooling Water
NH_3-N	Ammonia-Nitrogen
NPDES	National Pollutant Discharge Elimination System
NPS	Non Point Source
NTU	Nephelometric Turbidity Units
ORW	Outstanding Resource Waters
PAH	Polyaromatic Hydrocarbons
PALIS	Pond And Lake Information System
PCB	Polychlorinated Biphenols
PPM	Parts per Million
PWS	Public Water Supply
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/ Quality Control
RBP	Rapid Bioassessment Protocol
SARIS	Stream and River Inventory System
SS	Suspended Solids
SU	Standard Units
SWQS	Massachusetts Surface Water Quality Standards
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TRC	Total Residual Chlorine
USFDA	United States Food and Drug Administration
USGS	United States Geological Survey
VOC	Volatile Organic Compound
WMA	Water Management Act
WWTP	Waste Water Treatment Plant

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EXECUTIVE SUMMARY
CHARLES RIVER WATERSHED 1997/1998 WATER QUALITY ASSESSMENT REPORT

The assessment of current water quality conditions is a key step in the successful implementation of the watershed approach. This critical phase provides basic information for focusing resource protection and remediation activities to be executed later in the watershed management planning process. Detailed information regarding individual river segments and lakes in the Charles River Watershed is presented in this assessment report. The following summary provides an overview of the status of water quality conditions in the Charles River Watershed based on information available to DEP DWM as of February 1999.

CHARLES RIVER WATERSHED RIVERS

This report presents the status of 150.6 river miles in the Charles River Watershed. Numerous tributaries to the Charles River remain unassessed and are not included in this report. These include unnamed tributaries and the following 33 named brooks: Huckleberry, Beaver (Bellingham), Stall, Beaver (Waltham), Hopping, Miscoe, Dix, Chicken, Shepards, Uncas, Eagle, Miller, Cress, Stony, Horse, Sewall (Dover), Vine, Mill, Dirty Meadow, Sewall (Medfield), Indian, Davis, Bogle, Boulder, Noanet, Lowder, Hurd, Seaverns, Iron Mine, Cherry, Hobbs, Clematis, and Chester. Two channels, Fort Point and Reserved, are also unassessed.

AQUATIC LIFE USE

The *Aquatic Life Use* is met when suitable habitat (including water quality) is available for sustaining a native, naturally diverse, community of aquatic flora and fauna. The assessment status of this use is derived primarily from benthic community data (Figures 1, 2, and 3). The designation of the *Aquatic Life Use* as impaired (non or partial support) results from a combination of stressors including both point and nonpoint sources of pollution. The overall *Aquatic Life Use* status of the 150.6 river miles in the Charles River Watershed (mainstem and tributaries) discussed in this report is as follows:

Aquatic Life Use Summary

- 31.5 miles full support
- 50.3 miles partial support
- 49.4 miles non-support
- 19.4 miles not assessed

Upper/Middle Charles River

Along its upper and middle segments, the 37.9 mile reach of the Charles River (between Echo Lake in Milford and the South Natick Dam in Natick) receives the discharge from three major National Pollutant Discharge Elimination System (NPDES) permittees. These three wastewater treatment plants (WWTP) include Milford WWTP, Charles River Water Pollution Control District (CRWPCD), and Medfield Publicly Owned Treatment Works (POTW). In addition, public water supplies withdraw both surface and groundwater from sources along the mainstem Charles River and numerous tributaries.

Benthic community surveys upstream and downstream of the Milford WWTP indicated impairment both above and below the treatment plant, although no direct impacts were attributable to this discharge. The causes of impairment to the *Aquatic Life Use* were attributable to stormwater, illicit sewer connections, and other forms of urban runoff. Downstream from the CRWPCD discharge moderate impacts to the benthic community were detected and were attributed to nutrient loads and excessive organic enrichment from both this WWTP discharge (which also exhibits acute and chronic toxicity) and the upstream eutrophic impoundment (Populatic Pond). Further degradation of the benthic community was not identified downstream from the Medfield POTW. The Medfield POTW effluent did, however, exhibit acute and chronic toxicity. Organic enrichment, nutrients, and low levels of dissolved oxygen continue to be problematic and are likely a result of the cumulative effects of upstream wastewater discharges. Collectively, the *Aquatic Life Use* in the upper/middle Charles River is impaired for 22.9 river miles due to point and nonpoint source (NPS) pollution. The effects of water withdrawals on the *Aquatic Life Use* will require additional monitoring.

Lower Charles River

The lower third of the Charles River extends from the South Natick Dam to the New Charles River Dam, a total of 39.8 river miles. With the exception of stormwater and other minor discharges, the Massachusetts Water Resources Authority (MWRA) collects, treats, and discharges the municipal wastewater from the lower Charles River Watershed into Boston Harbor. There are 19 permitted combined sewer overflows (CSO) that discharge into the Charles River between the Watertown Dam and the New Charles River Dam (referred to as "the Basin") and only one receives treatment. These wastewater loads are the predominant source of pollutants in the Lower Basin.

The *Aquatic Life Use* for entire lower Charles (39.8 river miles) is impaired due to the degraded water quality and organic enrichment originating from stormwater, illicit sewer discharges and other forms of runoff associated with heavy urbanization. Significant acute sediment toxicity was also detected in the Basin.

Tributaries

The only tributary to the Charles River receiving sanitary wastewater discharges (Wrentham State School, Southwood Community Hospital and the Norfolk-MCI) is the Stop River. This river joins the Charles River between the CRWPCD discharge, Medway and the Medfield POTW, Medfield. This tributary was moderately to severely impacted by its point source discharges, as well as nonpoint source pollution in the form of sediment inputs (road runoff).

Current groundwater withdrawals exist along numerous tributaries including Mill River, Mine, Bogastow, Dopping and Jar brooks. While no definitive impacts were documented, the effects of these withdrawals will require continued monitoring. Additional (new) water withdrawals along tributaries continue to be a major concern. Baseline biological data were collected to assess potential impacts from new/proposed wells adjacent to Mill River and Dopping Brook.

Habitat degradation was observed in the form of sediment deposition and substrate embeddedness directly attributed to road runoff, construction activities, riparian zone disturbance, and other forms of NPS pollution in several tributaries that impairs the *Aquatic Life Use*. Specific areas of habitat degradation were identified in the following tributaries:

Jar Brook
- yard waste disposal piled adjacent to brook (subdivision upstream from Houghton Pond in Holliston)
- road runoff contributing to instream deposition (Westfield, Travis, Richard, and Rathellen roads and Maple Street).

Alder Brook
- sediment deposition at South Street crossing in Needham

Stony Brook
- sediment inputs at Church Street crossing in Weston

Cheese Cake Brook
- gross instream sediment deposition and riparian zone removal
- runoff from roads into the brook via numerous paved "swales" and stormdrains
- numerous construction activities adjacent to the brook - some with failing Best Management Practices (BMPs)

Although instream deposition in Stony Brook was not excessive, a fairly high priority should be put on remedying the problem (e.g., minor curb improvements), as this is probably the "least disturbed" stream reach in the entire Charles River Watershed in terms of water quality and biological integrity. Alder Brook could have potentially high habitat quality if sediment loads were reduced.

Trout, Rosemary and Fuller brooks were also impaired by NPS pollution. Although the cause of impairment to the *Aquatic Life Use* in Trout Brook is unknown, detrimental effects from agricultural practices are suspected. The impairment to the benthic community in Rosemary and Fuller brooks was associated with organic enrichment and nutrient loading most likely resulting from waterfowl feeding activities.

Tributaries represent 72.9 of the 150.6 river miles in the Charles River Watershed. Of these the *Aquatic Life Use* was impaired along 37 miles.

FISH CONSUMPTION USE

The *Fish Consumption Use* is met when pollutants do not result in unacceptable concentrations in edible portions of marketable fish or shellfish or for the recreational use of fish, shellfish, other aquatic life or wildlife for human consumption. The evaluation of this use, where fish toxics monitoring was conducted (Figures 1, 2, and 3) is assessed using the Department of Public Health's Fish Consumption Advisory List. Overall, the *Fish Consumption Use* for the entire Charles River Watershed (150.6 river miles) included in this report is summarized as follows:

Fish Consumption Use Summary

- 64.9 miles non-support
- 85.7 miles not assessed

Upper/Middle Charles River

An advisory for mercury contamination is in place for Cedar Swamp Pond (a 1.1 mile impounded reach of the Charles River in Milford). The advisory recommends that children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from Cedar Swamp Pond and that the general public should limit their consumption of any fish from this pond to two meals per month. An advisory is also in effect for the Charles River between the Medway and South Natick dams due to elevated mercury concentrations in largemouth bass. The advisory recommends that children younger than 12 years, pregnant women, and nursing mothers should not eat any largemouth bass and that the general public should limit their consumption of largemouth bass to two meals per month caught in this section of the river. A total of 20.9 river miles along the upper/middle Charles River are impaired for the *Fish Consumption Use*.

Lower Charles River

An advisory is in effect from the South Natick Dam to the Museum of Science Dam in Boston due to elevated levels of PCB in common carp. The advisory recommends that children younger than 12 years, pregnant women, and nursing mothers should not eat any carp caught in this section of the river and that the general public should limit their consumption of carp caught in this section of the river to two meals per month. A total of 39.8 river miles along the lower Charles River are impaired for the *Fish Consumption Use*.

Tributaries

An advisory is in place due to elevated PCB (carp, bullhead and American eel) for the Muddy River in Boston. The advisory recommends that children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from the Muddy River. It also recommends that the general public should not consume any carp, bullhead and American eel from the Muddy River, and limit consumption of non-affected fish from this river to two meals per month. A total of 4.2 miles are impaired for the *Fish Consumption Use* in this tributary. All other tributaries were not assessed for this use.

RECREATIONAL USES

The *Primary Contact Recreational Use* is defined as any recreation or other water activity during which there is prolonged and intimate contact with the water with a significant risk of ingestion. These include, but are not limited to, wading, swimming, diving, surfing and water skiing. The *Secondary Contact Recreational Use* is defined as any recreation or other water use during which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, boating and limited contact incident to shoreline activities. The overall support status (data summaries, Figures 1, 2, and 3) for the entire Charles River Watershed (150.6 river miles) included in this report are summarized as follows:

Primary Contact Recreational Use Summary

- 23.6 miles full support
- 21.5 miles partial support
- 73.5 miles non-support
- 32.0 miles not assessed

Secondary Contact Recreational Use Summary

- 28.1 miles full support
- 53.4 miles partial support
- 37.1 miles non-support
- 32.0 miles not assessed

Upper/Middle Charles River
Both the *Primary and Secondary Contact Recreational Uses* are impaired for 90% (34.3 river miles) along this reach of the Charles River. The cause of impairment is elevated levels of pathogens.

Lower Charles River
This entire reach of the mainstem Charles River (39.8 river miles) is assessed as impaired for both the *Primary and Secondary Contact Recreational Uses.*

Tributaries
Although other unknown discharges may exist, dry weather discharges associated with illicit sewer connections and/or failing infrastructure were primarily responsible for the high fecal coliform densities in several tributaries. Three brooks were heavily influenced by these dry weather discharges -- Sawmill Brook, near a large culverted stormdrain in St Joseph's Cemetery and approximately 150m upstream from Baker Street in Boston, Beaver Brook underneath the Route 60 road crossing and upstream from Lyman Pond in Waltham, and Cheese Cake Brook upstream from Watertown Street, Newton.

Dry weather discharges probably affect South Meadow Brook (downstream from Needham Street, Newton) although sources were not identified. High fecal coliform densities were also found in Laundry Brook. The completely underground nature of this urban tributary makes investigations into its stormwater (dry and wet weather) inputs difficult. Fecal coliform contamination was also identified in segments where pet walking and/or waterfowl feeding activities were common – Fuller Brook, Cheese Cake Brook and in the Lakes District.

The *Primary Contact Recreational Use* of the tributaries in the Charles River Watershed was impaired for 20.9 river miles. The *Secondary Contact Recreational Use* was impaired for 15.4 of the 72.9 tributary river miles in the Charles River Watershed.

AESTHETICS USE

The *Aesthetics Use* is met when surface waters are free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life. The overall *Aesthetics Use* status (data summary, Figures 1, 2, and 3) of the 150.6 river miles in the Charles River Watershed (mainstem and tributaries) discussed in this report follows:

Aesthetics Use Summary
- 52.4 miles full support
- 42.8 miles partial support
- 35.0 miles non-support
- 20.4 miles not assessed

Upper, Middle and Lower Charles River
Nuisance aquatic vegetation and turbidity impairs the aesthetic quality throughout most of the upper/middle mainstem Charles River. Other causes of impairment (particularly in the Lower Charles Basin) were also noted (odors, objectionable solids, and oils). Collectively, impairment of the *Aesthetics Use* was identified along 79% of the mainstem Charles River.

Tributaries
Eleven of the nineteen tributaries were assessed as full support for the *Aesthetics Use*. In the eight tributaries where this use was impaired, sediment deposition, instream vegetation, sewage odors, turbidity, and/or oil slicks caused impairment.

CHARLES RIVER WATERSHED LAKES

Overall use support status and trophic status of the lakes surveyed in the Charles are presented in Tables 1 and 2, respectively. It should be noted that lakes or portions of lakes were listed as undetermined when indicators were not readily observable. With this approach, the assessment of lakes in the Charles is limited to a "best case" picture (i.e., only the most obvious impairments are reported). Potentially more of the lake acreage would be listed as impaired or in a more enriched trophic status if more variables were measured and more criteria assessed. Surveys also focused on the presence or absence of non-native macrophytes. Six non-native aquatic species and two non-native wetland species were observed.

Table 1. Charles River Watershed lakes use support summary (in acres).

USE/DEGREE SUPPORTED	SUPPORT	PARTIAL SUPPORT	NON SUPPORT	NOT ASSESSED	NOT ATTAINABLE
AQUATIC LIFE	0	514	0	2264	97
FISH CONSUMPTION*	0	0	147	2631	97
SWIMMABLE	0	245	429	2104	97
SECONDARY CONTACT	2167	156	429	26	97
AESTHETICS	2167	156	429	26	97

Fish Consumption results do not include the statewide consumption advisory (i.e., they are site-specific advisories as reported by the Department of Public Health (1998).

N.B. - These results represent the most recent assessments of lakes/ponds in the Charles River Watershed. These data also represent about 28% (41 of 148) of the lakes/ponds in the Charles watershed and about 69% (2875 of 4165) of the acreage.

Table 2. Charles River Watershed lakes trophic status summary.

TROPHIC STATUS	NUMBER OF LAKES	ACRES
Oligotrophic	0	0
Mesotrophic	4	582
Eutrophic	10	614
Hypereutrophic	12	340
Dystrophic	0	0
Undetermined/ Not Attainable	15	1339
Total	41	2875

N.B. - These results represent the most recent assessments of lakes/ponds in the Charles River Watershed. These data also represent about 28% (41 of 148) of the lakes/ponds in the Charles watershed and about 69% (2875 of 4165) of the acreage.

Despite the "best case" scenario that is favored by the Charles River Watershed lake assessment approach, 54% (representing 33% of the surveyed area) of the lakes showed severe (eutrophic or hypereutrophic) symptoms of succession. Presumably additional testing of dissolved oxygen, chlorophyll, and/or nutrients would corroborate the evidence of the advanced trophic status.

One non-native aquatic plant species, variable water milfoil, was commonly found in the Charles River Watershed. Five other non-native aquatic plant species were found infrequently. Three of these non-native species (fanwort, variable and Eurasian water milfoil) are particularly invasive. They spread vegetatively via cuttings that may float downstream or are transported mechanically between lakes. Yellow floating heart, curly leaf pondweed, and water chestnut spread readily from seeds which may be transported downstream. The nutlets of the water chestnut are more likely transported to new locations via waterfowl or aquatic mammals.

Purple loosestrife was the most frequently occurring non-native wetland species. Populations of this plant are pervasive throughout the watershed. Its presence was recorded at 72% of the lakes in this watershed. The common reed grass, a non-native wetland plant was also observed in the Charles. These two non-native wetland species were co-located at Lake Archer, Wrentham and Pleasant Street Pond, Franklin.

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Upper Charles River Watershed
Water Quality Assessment Summary

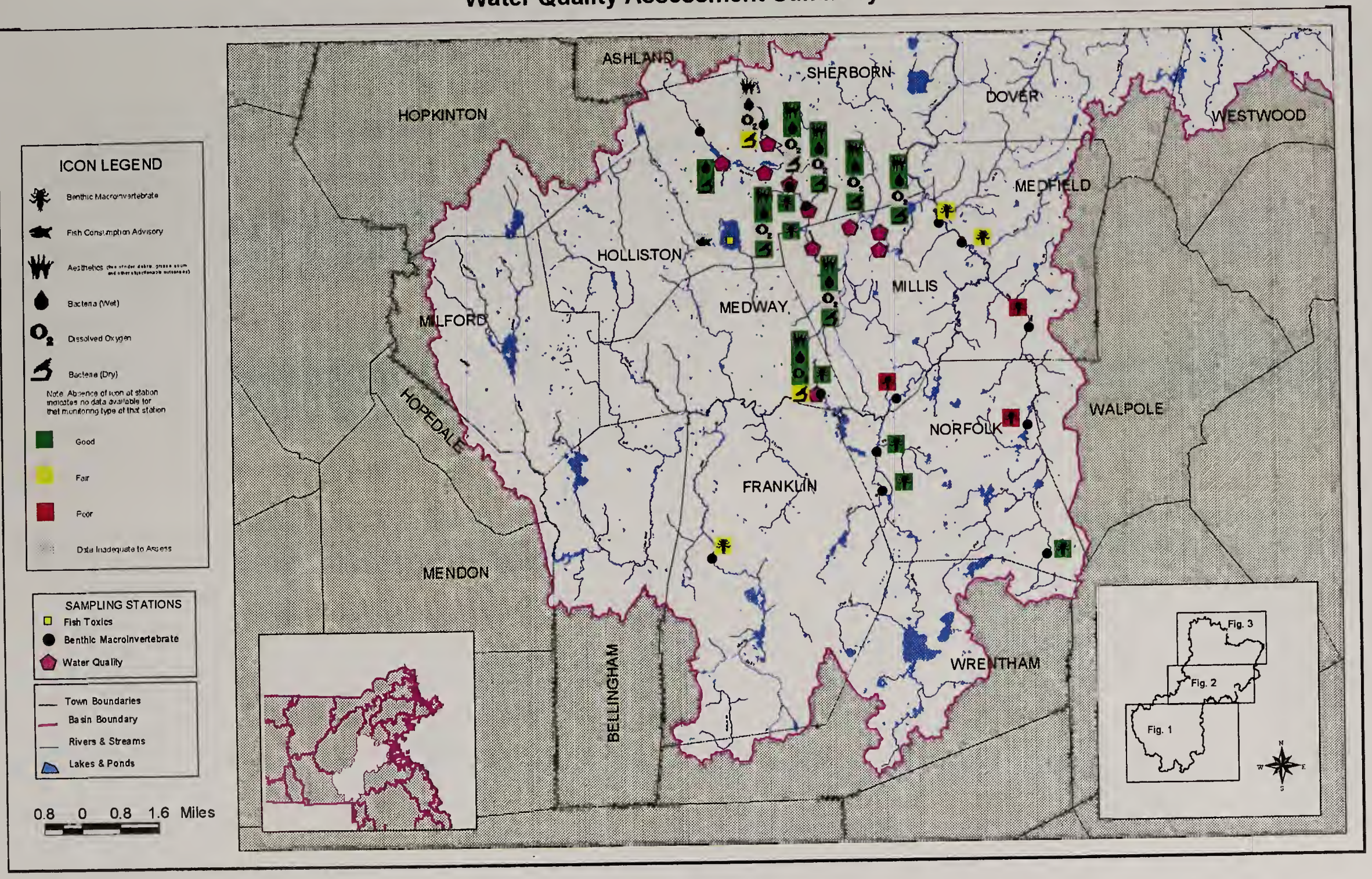

Figure 1. DEP DWM Water quality, macroinvertebrate, and fish consumption advisory station data evaluations, Upper Charles River Watershed

Middle Charles River Watershed
Water Quality Assessment Summary

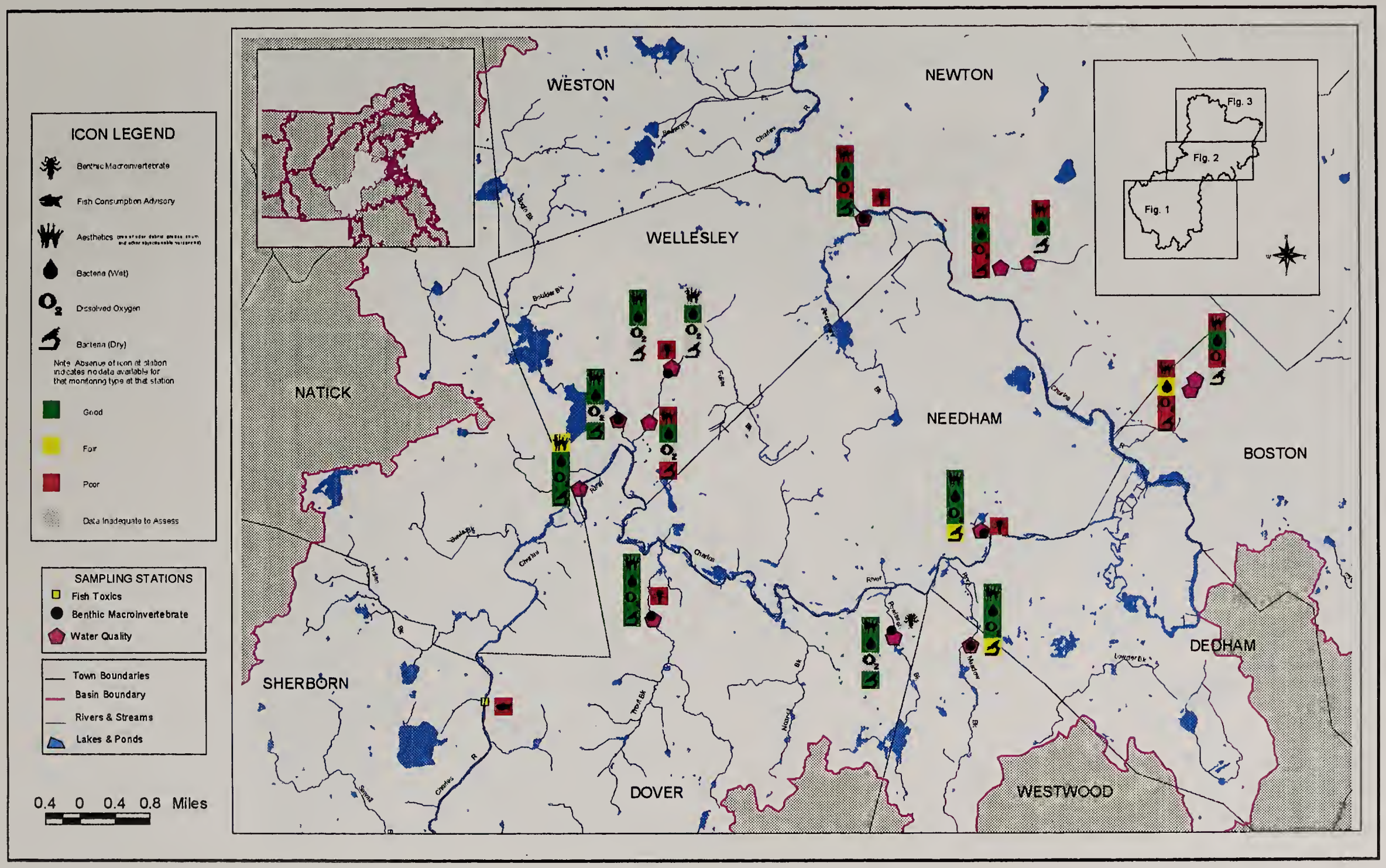

Figure 2. DEP DWM Water quality, macroinvertebrate, and fish consumption advisory station data evaluations, Middle Charles River Watershed

Lower Charles River Watershed
Water Quality Assessment Summary

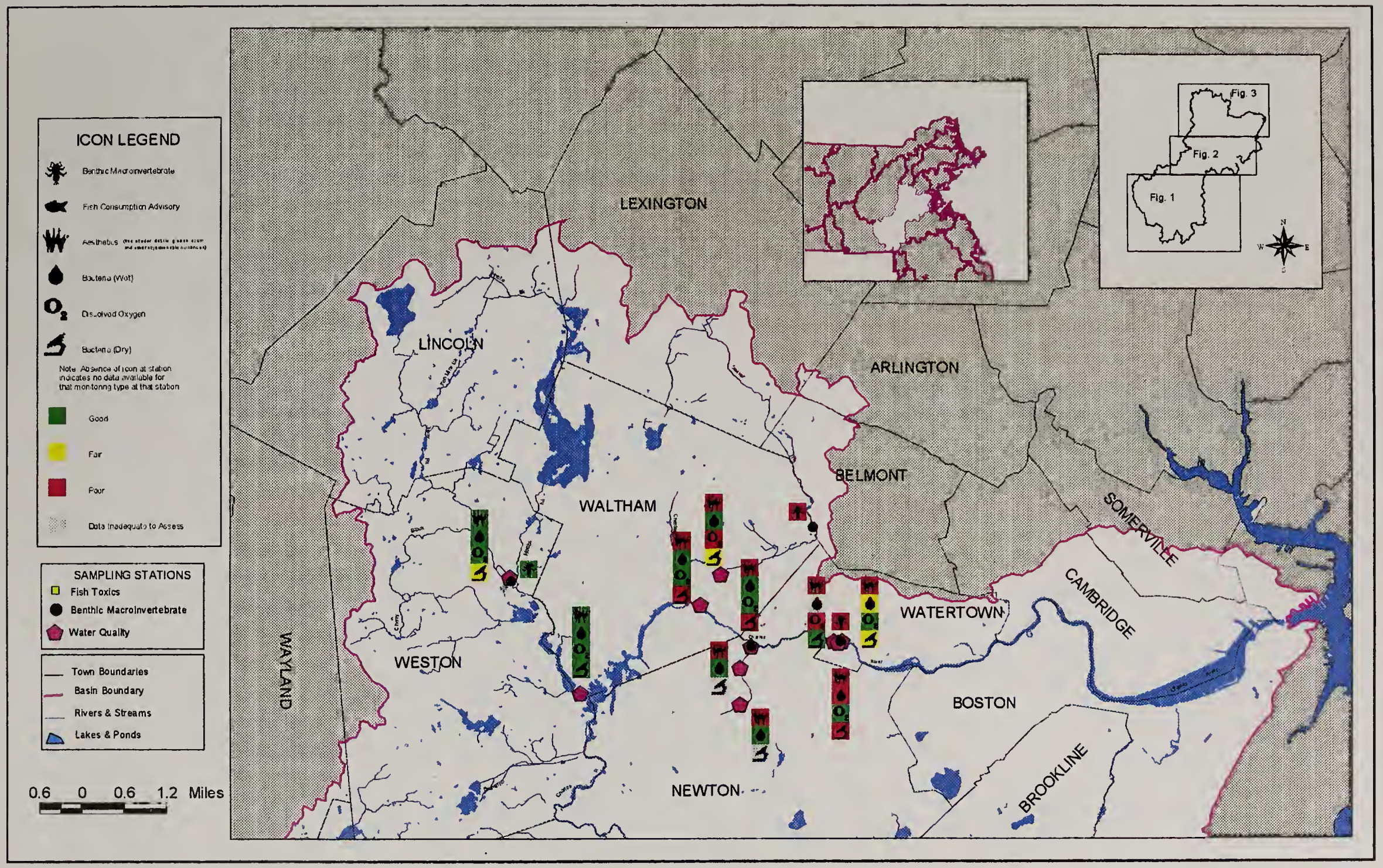

Figure 3. DEP DWM Water quality, macroinvertebrate, and fish consumption advisory station data evaluations, Lower Charles River Watershed

INTRODUCTION

The Massachusetts Watershed Initiative is a collaborative effort between state and federal environmental agencies, citizens, non-profit groups, businesses and industries in the watershed. The mission is to improve water quality conditions and to provide a framework under which the restoration and/or protection of the basin's natural resources can be achieved. Implementation of this project is underway in a process known as the "Watershed Approach". The five-year cycle of the Watershed Approach, as illustrated in Figure 4, provides the management structure to carry out the mission. This report presents the assessment of water quality conditions in the Charles River Basin. The assessment is based on information that has been researched and developed through the first three years (information gathering, monitoring, and assessment) of the five year cycle by the Department of Environmental Protection (DEP) as part of its federal mandate under the Federal Water Pollution Control Act (commonly known as the Clean Water Act).

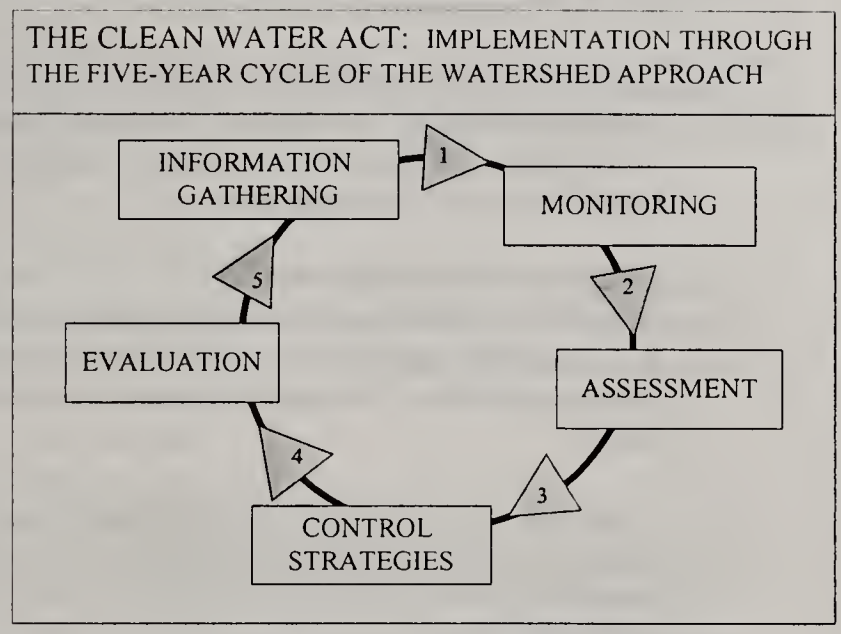

Figure 4. Clean Water Act Implementation Cycle.

The objective of the Clean Water Act (CWA) is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (Environmental Law Reporter 1988). To meet this goal, the CWA requires states to develop information on the quality of the Nation's water resources and report this information to the U.S. Environmental Protection Agency (EPA), the U.S. Congress, and the public. Together, these agencies are responsible for implementation of the CWA mandates. Under Section 305(b) of the Federal Clean Water Act, DEP must submit a statewide report every two years to the EPA, which describes the status of water quality in the Commonwealth. The most recent 305(b) report is the *Commonwealth of Massachusetts Summary of Water Quality 1998* (MA DEP 1998a). The 305(b) statewide report is based on the compilation of the Commonwealth's 27 watershed water quality assessment reports. The 305(b) report compiles data from a variety of sources, and provides an evaluation of water quality, progress made towards maintaining and restoring water quality, and the extent to which problems remain. Reporting on the status of the water quality conditions follows a standardized process described in the assessment methodology. This process involves the analyzing of biological, habitat, physical/chemical, and/or toxicity data and other information to assess the degree of use support, and identify causes and sources of water quality impairment. This 1997/1998 Charles River Watershed Water Quality Assessment Report is an integral component of the 305(b) reporting process.

ASSESSMENT METHODOLOGY

WATER QUALITY CLASSIFICATION

The Massachusetts Surface Water Quality Standards designate the most sensitive uses for which the surface waters of the Commonwealth shall be enhanced, maintained and protected; prescribe minimum water quality criteria required to sustain the designated uses; and include provisions for the prohibition of discharges (MADEP 1996). These regulations undergo public review every three years. These surface waters are segmented and each segment is assigned to one of the six classes described below:

Inland Water Classes

1. *Class A – These waters are designated as a source of public water supply. To the extent compatible with this use they shall be an excellent habitat for fish, other aquatic life and wildlife, and suitable for primary and secondary contact recreation. These waters shall have excellent aesthetic value. These waters are designated for protection as Outstanding Resource Waters (ORW's) under 314 CMR 4.04(3).*

2. *Class B – These waters are designated as a habitat for fish, other aquatic life, and wildlife, and for primary and secondary contact recreation. Where designated they shall be suitable as a source of water supply with appropriate treatment. They shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*

3. *Class C – These waters are designated as a habitat for fish, other aquatic life and wildlife, and for secondary contact recreation. These waters shall be suitable for the irrigation of crops used for consumption after cooking and for compatible industrial cooling and process uses. These waters shall have good aesthetic value.*

Coastal and Marine Classes

4. *Class SA – These waters are designated as an excellent habitat for fish, other aquatic life and wildlife and for primary and secondary recreation. In approved areas they shall be suitable for shellfish harvesting without depuration (Open Shellfishing Areas). These waters shall have excellent aesthetic value.*

5. *Class SB – These waters are designated as a habitat for fish, other aquatic life and wildlife and for primary and secondary contact recreation. In approved areas they shall be suitable for shellfish harvesting with depuration (Restricted Shellfishing Areas). These waters shall have consistently good aesthetic value.*

6. *Class SC – These waters are designated as a habitat for fish, other aquatic life, and wildlife and for secondary contact recreation. They shall also be suitable for certain industrial cooling and process uses. These waters shall have good aesthetic value.*

The CWA Section 305(b) water quality reporting process is an essential aspect of the Nation's water pollution control effort. It is the principal means by which EPA, Congress, and the public evaluate existing water quality, assess progress made in maintaining and restoring water quality, and determine the extent of remaining problems. In so doing, the States report on waterbodies within the context of meeting their designated uses (described above in each class). Each class is identified by the most sensitive, and therefore governing, water uses to be achieved and protected. These uses include: Aquatic Life, Fish Consumption, Drinking Water, Primary and Secondary Contact Recreation, Shellfishing and Aesthetics. Three subclasses of Aquatic Life are also designated in the standards: Cold Water Fishery (capable of sustaining a year-round population of cold water aquatic life such as trout), Warm Water Fishery (waters which are not capable of sustaining a year-round population of cold water aquatic life), and Marine Fishery (suitable for sustaining marine flora and fauna).

A summary of the State Water Quality Standards (Table 3) prescribes minimum water quality criteria to sustain the designated uses. Furthermore these standards describe the hydrological conditions at which water quality criteria must be met (MA DEP 1996). In rivers and streams, the lowest flow conditions at and above which criteria must be met is the lowest mean flow for seven consecutive days to be expected once in ten years (7Q10). In artificially regulated waters, the lowest flow conditions at which criteria must be met is the flow equal or exceeded 99% of the time on a yearly basis or another equivalent flow which has been agreed upon. In coastal and marine waters and for lakes and ponds the most severe hydrological condition is determined by DEP on a case by case basis.

The availability of appropriate and reliable scientific data and technical information is fundamental to the 305(b) reporting process. It is EPA policy (EPA Order 5360.1 CHG 1) that any organization performing work for or on behalf of EPA establish a Quality System to support the development, review, approval, implementation, and assessment of data collection operations. To this end, DEP describes its Quality System in an EPA-approved Quality Management Plan (QMP) to ensure that environmental data collected or compiled by the Agency are of known and documented quality and are suitable for their intended use. For external sources of information, DEP requires the following: 1) an appropriate *Quality Assurance Project Plan* including a QA/QC plan, 2) use of a state certified lab (certified in the applicable analysis), 3) data management QA/QC be described, and 4) the information be documented in a citable report.

Table 3 Summary of Massachusetts Surface Water Quality Standards (MADEP 1996). Note: Italics are direct quotations.

Dissolved Oxygen	Class A, BCWF*, SA : ≥ 6.0 mg/L and ≥ 75% saturation unless background conditions are lower Class BWWF**, SB: ≥ 5.0 mg/L and ≥ 60% saturation unless background conditions are lower Class C: Not ≤ 5.0 mg/L for more than 16 of any 24 –hour period and not ≤ 3.0 mg/L anytime unless background conditions are lower; levels cannot be lowered below 50% saturation due to a discharge Class SC: Not ≤ 5.0 mg/L for more than 16 of any 24 –hour period and not ≤ 4.0 mg/L anytime unless background conditions are lower; and 50% saturation; levels cannot be lowered below 50% saturation due to a discharge
Temperature	Class A: ≤ 68°F (20°C) and Δ 1.5°F (0.8°C) for Cold Water and ≤ 83°F (28.3°C) and Δ 1.5°F (0.8°C) for Warm Water Class BCWF: ≤ 68°F (20°C) and Δ3°F (1.7°C) due to a discharge Class BWWF: ≤ 83°F (28.3°C) and Δ3°F (1.7°C) in lakes, Δ5°F (2.8°C) in rivers Class C, SC: ≤85°F (29.4°C) nor Δ5°F (2.8°C) due to a discharge Class SA: ≤85°F (29.4°C) nor a maximum daily mean of 80°F (26.7°C) and Δ1.5°F (0.8°C) Class SB: ≤85°F (29.4°C) nor a maximum daily mean of 80°F (26.7°C) and Δ1.5°F (0.8°C) between July through September and Δ 4.0°F (2.2°C) between October through June
pH	Class A, BCWF, BWWF: 6.5 – 8.3 and Δ0.5 outside the background range. Class C: 6.5 – 9.0 and Δ1.0 outside the naturally occurring range. Class SA, SB: 6.5 – 8.5 and Δ0.2 outside the normally occurring range. Class SC: 6.5 – 9.0 and Δ0.5 outside the naturally occurring range.
Fecal Coliform Bacteria	Class A: an arithmetic mean of < 20 organisms /100 ml in any representative set of samples and < 10% of the samples > 100 organisms/100 ml. Class B: a geometric mean of < 200 organisms /100 ml in any representative set of samples and < 10% of the samples > 400 organisms /100 ml. (This criterion can be applied on a seasonal basis at the discretion of the DEP.) Class C: a geometric mean of < 1000 organisms /100ml, and < 10% of the samples > 2000 organisms/100 ml. Class SA: approved Open Shellfish Areas: a geometric mean (MPN method) of < 14 organisms/100 ml and < 10% of the samples > 43 organisms/100 ml (MPN method). Waters not designated for shellfishing: < a geometric mean of 200 organisms in any representative set of samples, and < 10% of the samples > 400 organisms /100 ml. (This criterion can be applied on a seasonal basis at the discretion of the DEP.) Class SB: approved Restricted Shellfish Areas: < a fecal coliform median or geometric mean (MPN method) of 88 organisms/100 ml and < 10% of the samples > 260 organisms /100 ml (MPN method). Waters not designated for shellfishing: < a geometric mean of 200 organisms in any representative set of samples, and < 10% of the samples > 400 organisms /100 ml. (This criterion can be applied on a seasonal basis at the discretion of the DEP.) Class SC: < a geometric mean of 1000 organisms/100 ml and < 10% of the samples > 2000 organisms/100ml.
Solids	All Classes: *These waters shall be free from floating, suspended, and settleable solids in concentrations or combinations that would impair any use assigned to each class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.*
Color and Turbidity	All Classes: *These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use.*
Oil & Grease	Class A, SA: *Waters shall be free from oil and grease, petrochemicals and other volatile or synthetic organic pollutants.* Class SA: *Waters shall be free from oil and grease and petrochemicals.* Class B, C,SB, SC: *Waters shall be free from oil and grease, petrochemicals that produce a visible film on the surface of the water, impart an oily taste to the water or an oily or other undesirable taste to the edible portions of aquatic life, coat the banks or bottom of the water course or are deleterious or become toxic to aquatic life.*
Taste and Odor	Class A, SA: *None other than of natural origin.* Class B, C,SB, SC: *None in such concentrations or combinations that are aesthetically objectionable, that would impair any use assigned to each class, or that would cause tainting or undesirable flavors in the edible portions of aquatic life.*
Aesthetics	All Classes: *All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.*
Toxic Pollutants (7)	All Classes: *All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife… The division shall use the recommended limit published by EPA pursuant to 33 USC 1251, 304(a) as the allowable receiving water concentrations for the affected waters unless a site-specific limit is established.*
Nutrients	*Shall not exceed the site-specific limits necessary to control accelerated or cultural eutrophication.*

*Class BCWF = Class B Cold Water Fishery, ** Class BWWF = Class B Warm Water Fishery, Δ criterion (referring to a change from ambient) is applied to the effects of a permitted discharge.

EPA provides guidelines to the States for making their use support determinations (EPA 1997). The determination of whether or not a waterbody supports each of its designated uses is a function of the type(s), quality and quantity of available current information. Each designated use within a given segment is individually assessed as 1) ***support***, 2) ***partial support***, or 3) ***non-support***. The term ***threatened*** is used when the use is fully supported but may not support the use within two years because of adverse pollution trends or anticipated sources of pollution. When too little current data/information exists or no reliable data are available the use is ***not assessed***. Although data/information older than five years are usually considered "historical" and used for descriptive purposes, they can be utilized in the use support determination providing they are known to reflect the current conditions. While the water quality standards (Table 3) prescribe minimum water quality criteria to sustain the designated uses, numerical criteria are not available for every indicator of pollution. Best available guidance in the literature may be applied in lieu of actual numerical criteria (e.g., freshwater sediment data may be compared to *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* 1993 by D. Persaud, R. Jaagumagi and A. Hayton).

DESIGNATED USES

The Massachusetts Surface Water Quality Standards designate the most sensitive uses for which the surface waters of the Commonwealth shall be enhanced, maintained and protected. Each of these uses is briefly described below (MA DEP 1996):

- AQUATIC LIFE - suitable habitat for sustaining a native, naturally diverse, community of aquatic flora and fauna. Three subclasses of aquatic life are also designated in the standards for freshwater bodies; *Cold Water Fishery* - capable of sustaining a year-round population of cold water aquatic life such as trout, *Warm Water Fishery* - waters which are not capable of sustaining a year-round population of cold water aquatic life, and *Marine Fishery* - suitable for sustaining marine flora and fauna.

- FISH CONSUMPTION - pollutants shall not result in unacceptable concentrations in edible portions of marketable fish or shellfish or for the recreational use of fish, shellfish, other aquatic life or wildlife for human consumption.

- DRINKING WATER - used to denote those waters used as a source of public drinking water. They may be subject to more stringent regulation in accordance with the Massachusetts Drinking Water Regulations (310 CMR 22.00). These waters are designated for protection as Outstanding Resource Waters under 314 CMR 4.04(3).

- PRIMARY CONTACT RECREATION - suitable for any recreation or other water use in which there is prolonged and intimate contact with the water with a significant risk of ingestion of water. These include, but are not limited to, wading, swimming, diving, surfing and water skiing.

- SECONDARY CONTACT RECREATION - suitable for any recreation or other water use in which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, boating and limited contact incident to shoreline activities.

- AESTHETICS - all surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.

- AGRICULTURAL AND INDUSTRIAL - suitable for irrigation or other agricultural process water and for compatible industrial cooling and process water.

- SHELLFISH HARVESTING (in SA and SB segments) – Class SA waters in approved areas (Open Shellfish Areas) shellfish harvested without depuration shall be suitable for consumption; Class SB waters in approved areas (Restricted Shellfish Areas) shellfish harvested with depuration shall be suitable for consumption.

Other restrictions which denote specific subcategories of use assigned to the segment that may affect the application of criteria or specific antidegradation provision of 314 CMR 4.00 which are specified along segments of the Charles River include:

- CSO – These waters are identified as impacted by the discharge of combined sewer overflows in the classification tables in 314 CMR 4.06(3). Overflow events may be allowed by the permitting authority without a variance or partial use designation where the provisions 314 CMR 4.06(1)(d)10 are met. The waterbody may be subject to short-term impairment of swimming or other recreational uses, but support these uses through most of their annual period of use; and the aquatic life community may suffer some adverse impact yet is still generally viable).

The guidance used to assess each designated use follows.

AQUATIC LIFE USE

This use is suitable for sustaining a native, naturally diverse, community of aquatic flora and fauna. The results of biological (and habitat), toxicological, and chemical data are integrated to assess this use. The nature, frequency, and precision of the DEP's data collection techniques dictate that a weight of evidence be used to make the assessment, with biosurvey results used as the final arbiter of borderline cases. The following chart provides an overview of the guidance used to assess the status (support, partial support, non-support) of the aquatic life use:

Variable (# indicates reference)	***Support***—Data available clearly indicates support. Minor excursions from chemical criteria (Table 3) may be tolerated if the biosurvey results demonstrate support.	***Partial Support*** -- Uncertainty about support in the chemical or toxicity testing data, or there is some minor modification of the biological community. Excursions not frequent or prolonged.	***Non-support*** -- There are frequent or severe violations of chemical criteria, presence of acute toxicity, or a moderate or severe modification of the biological community.
BIOLOGY			
Rapid Bioassessment Protocol (RBP) II or III (4)	Non-Impaired	Slightly Impaired	Moderately or Severely Impaired
Fish Community (4)	BPJ*	BPJ*	BPJ*
Habitat and Flow (4)	BPJ*	BPJ*	Dry Streambed due to artificial regulation or channel alteration
Macrophytes (4)	No non-native plant species present, BPJ	Non-native plant species present but not dominant, BPJ*	Non-native plant species dominant, BPJ*
Plankton/ Periphyton (4)	No algal blooms	Occasional algal blooms	Persistent algal blooms
TOXICITY TESTS			
Water Column (4)	>75% survival either 48 hr or 7-day exposure	>50 - ≤75% survival either 48 hr or 7-day exposure	≤50% survival either 48 hr or 7-day exposure
Effluent (4)	Meets permit limits	(NOTE: if limit is not met, the stream is listed as threatened for 1.0 river mile downstream from the discharge.)	
Sediment (4)	>75% survival	>50 - ≤75% survival	≤50% survival
CHEMISTRY- WATER			
DO (3, 6)	Criteria (Table 3)	Criteria exceed in 11-25% of measurements.	Criteria exceeded >25% of measurements.
pH (3, 6)	Criteria (Table 3)	Criteria exceed in 11-25% of measurements.	Criteria exceeded >25% of measurements.
Temperature (3, 6) ***	Criteria (Table 3), ***	Criteria exceed in 11-25% of measurements.	Criteria exceeded >25% of measurements.
Turbidity (4)	Δ 5 NTU due to a discharge	BPJ*	BPJ *
Suspended Solids (4)	25 mg/L max., Δ10 mg/L due to a discharge	BPJ*	BPJ*
Nutrients (3) Phosphate-P (4)	Table 3, (Site-Specific Criteria; Maintain Balanced Biocommunity, no pH/DO violations)	BPJ*	BPJ*
Toxic Pollutants (3, 6) Ammonia-N (3, 4) Chlorine (3, 6)	Criteria (Table 3) 0.254 mg/L**** NH_3-N 0.011 mg/L TRC	Criterion is exceed in ≤ 10% of samples.	Criterion is exceed in > 10% of samples.
CHEMISTRY – SEDIMENT			
Toxic Pollutants (5)	≤ L-EL*****	One pollutant between L-EL and S-EL	One pollutant ≥ S-EL
Nutrients (5)	≤ L-EL	between L-EL and S-EL	≥ S-EL
Metal Normalization to Al or Fe (4)	Enrichment Ratio ≤ 1	Enrichment Ratio >1 but ≤10	Enrichment Ratio ≥10
CHEMISTRY- EFFLUENT			
Compliance with permit limits (4)	In-compliance with all limits	NOTE: If the facility is not in compliance with their permit limits, the information is used to threaten one river mile downstream from the discharge.	
CHEMISTRY-TISSUE			
PCB – whole fish (1)	≤500 µg/Kg wet weight	BPJ*	BPJ*
DDT (2)	≤14.0 µg/Kg wet weight	BPJ*	BPJ*
PCB in aquatic tissue (2)	≤0.79 ng TEQ/Kg wet weight	BPJ*	BPJ*

*BPJ = Best Professional Judgement, ***maximum daily mean temp. in a month (minimum of 6 measurements evenly distributed over 24-hours) <criterion, ****Ammonia levels for pH of 9.0, actual "criterion" varies with pH and is evaluated case-by-case, *****L-EL = Low Effect Level and S-EL = Severe Effect Level

FISH CONSUMPTION USE

Pollutants shall not result in unacceptable concentrations in edible portions of marketable fish or shellfish or for the recreational use of fish, shellfish, other aquatic life or wildlife for human consumption. This assessment is made using the most recent list of Fish Consumption Advisories issued by the Massachusetts Executive Office of Health and Human Services, Department of Public Health (DPH), Bureau of Environmental Health Assessment Fish Consumption Advisory List. Following is an overview of the guidance used to assess the status (support, partial support, non-support) of the fish consumption use.

Variable (# indicates reference)	***Support*** —No restrictions or bans in effect	***Partial Support*** – A "restricted consumption" fish advisory is in effect for the general population or a sub-population that could be at potentially greater risk (e.g., pregnant women, and children	***Non-support*** – A "no consumption" advisory or ban in effect for the general population or a sub-population for one or more fish species; or there is a commercial fishing ban in effect
DPH Fish Consumption Advisory List (8)	Not applicable, precluded by statewide advisory (Hg)	Not applicable	Waterbody on DPH Fish Consumption Advisory List

* NOTE: In 1994, DPH issued a statewide *Interim Freshwater Fish Consumption Advisory* for mercury. This precautionary measure was aimed at pregnant women only; the general public was not considered to be at risk from fish consumption. The advisory encompasses all freshwaters in Massachusetts therefore the *Fish Consumption Use* will no longer be assessed as support.

DRINKING WATER USE

Drinking Water Use denotes those waters used as a source of public drinking water. These waters may be subject to more stringent regulation in accordance with the Massachusetts Drinking Water Regulations (310 CMR 22.00). They are designated for protection as Outstanding Resource Waters in 314 CMR 4.04(3). This use is assessed by DEP's Drinking Water Program (DWP). The use is not assessed when the source has been placed on "emergency or backup" status since no testing is required. Below is an overview of the guidance used to assess the status (support, partial support, non-support) of the drinking water use.

Variable (# indicates reference)	***Support***-- No closures or advisories (no contaminants with confirmed exceedences of MCLs, conventional treatment is adequate to maintain the supply).	***Partial Support*** – Is one or more advisories or more than conventional treatment is required	***Non-support*** – One or more contamination-based closures of the water supply
Drinking Water Program (DWP) Evaluation	Reported by DWP	Reported by DWP	Reported by DWP

PRIMARY CONTACT RECREATIONAL USE

This use is suitable for any recreational or other water use in which there is prolonged and intimate contact with the water with a significant risk of ingestion of water (1 April to 15 October). These include, but are not limited to, wading, swimming, diving, surfing and water skiing. The chart below provides an overview of the guidance used to assess the status (support, partial support, non-support) of the primary contact use.

Variable (# indicates reference)	***Support***-- Criteria are met, no aesthetic conditions that preclude the use	***Partial Support*** –Criteria exceeded intermittently (neither frequent nor prolonged), marginal aesthetic violations	***Non-support*** –Frequent or prolonged violations of criteria, formal bathing area closures, or severe aesthetic conditions that preclude the use
Fecal Coliform Bacteria (3, 9) *	Criteria met (Table 3) OR Dry Weather Guidance <5 samples–≤400/100 ml maximum Wet Weather Guidance Dry weather samples meet and wet samples ≤2000/100 ml	Guidance exceeded in 11-25% of the samples OR Wet Weather Dry weather samples meet and wet samples ≥2000/100 ml	Guidance exceeded in > 25% of the samples
pH (3, 6)	Criteria (Table 3) exceeded in ≤10% of the measurements	Criteria exceeded in 11-25% of the measurements	Criteria exceeded in >25% of the measurements
Temperature (3)	Criteria met (Table 3)	Criteria exceeded 11-25% of the time	Criteria exceeded 25% of the time
Color and Turbidity (3, 6)	Δ 5 NTU (due to a discharge) exceeded in <10 % of the measurements	Guidance exceeded in 11-25% of the measurements	Guidance exceeded in >25% of the measurements
Secchi disk depth (10)**	Lakes - ≥1.2 meters (≥ 4')	Infrequent excursions from the guidance	Frequent and/or prolonged excursions from the guidance
Oil & Grease (3)	Criteria met (Table 3)	Criteria exceeded 11-25% of the time	Criteria exceeded >25% of the time
Aesthetics (3) Biocommunity (4)**	No nuisance organisms that render the water aesthetically objectionable or unusable; Lakes – cover of macrophytes < 50% of lake area at maximum extent of growth.	Lakes – cover of macrophytes 50-75% of lake area at their maximum extent of growth.	Lakes – cover of macrophytes >75% of lake area at their maximum extent of growth.

Note: Excursions from criteria due to natural conditions are not considered impairment of use.

* Fecal Coliform bacteria interpretations require additional information in order to apply this use assessment guidance. Bacteria data results (fecal coliform) are interpreted according to whether they represent dry weather or wet weather (stormwater runoff) conditions. Accordingly it is important to interpret the amount of precipitation received in the subject region immediately prior to sampling and streamflow conditions.

** Lakes exhibiting impairment of the primary contact recreation use (swimmable) because of macrophyte cover and/or transparency (Secchi disk depth) are assessed as either *partial* or *non-support*. If no fecal coliform bacteria data are available and the lake (entirely or in part) met the transparency (Secchi disk depth) and aesthetics guidance this use is *not assessed*.

SECONDARY CONTACT RECREATIONAL USE

This use is suitable for any recreation or other water use in which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, boating and limited contact incident to shoreline activities. Following is an overview of the guidance used to assess the status (support, partial support, non-support) of the secondary contact use.

Variable (# indicates reference)	***Support***-- Criteria are met, no aesthetic conditions that preclude the use	***Partial Support*** –Criteria exceeded intermittently (neither frequent nor prolonged), marginal aesthetic violations	***Non-support*** –Frequent or prolonged violations of criteria, or severe aesthetic conditions that preclude the use
Fecal Coliform Bacteria (4) *	Dry Weather Guidance <5 samples--≤2000/100 ml maximum >5 samples--≤1000/100 ml geometric mean ≤ 10% samples ≥2000/100 ml Wet Weather Guidance Dry weather samples meet and wet samples ≤4000/100 ml	Wet Weather Guidance Dry weather samples meet and wet samples ≥4000/100 ml	Criteria exceeded in dry weather
Oil & Grease (3)	Criteria met (Table 3)	Criteria exceeded 11-25% of the time	Criteria exceeded >25% of the time
Aesthetics (3) Biocommunity (4) **	No nuisance organisms that render the water aesthetically objectionable or unusable; Lakes – cover of macrophytes < 50% of lake area at their maximum extent of growth.	Macrophyte cover is between 50 – 75%	Macrophyte cover exceeds 75% of the lake area.

Note: Excursions from criteria due to natural conditions are not considered impairment of use.

* Fecal Coliform bacteria interpretations require additional information in order to apply this use assessment guidance. Bacteria data results (fecal coliform) are interpreted according to whether they represent dry weather or wet weather (stormwater runoff) conditions. Accordingly it is important to interpret the amount of precipitation received in the study region immediately prior to sampling and streamflow conditions.

** In lakes if no fecal coliform data are available, macrophyte cover is the only criterion used to assess the secondary contact recreational use.

For the Primary and Secondary Contact Recreational uses the following steps are taken to interpret the fecal coliform bacteria results:

1. Identify the range of fecal coliform bacteria results,
2. Calculate the geometric mean (monthly, seasonally, or on dataset), (Note: the geometric mean is only calculated on datasets with >5 samples collected in a 30 day period.)
3. Calculate the % of sample results exceeding 400 cfu/100 mls,
4. Determine if the samples were collected during wet or dry weather conditions (review precipitation and streamflow data),
   - Dry weather can be defined as: No/trace antecedent (to the sampling event) precipitation that causes more than a slight increase in stream flow.
   - Wet weather can be defined as: Precipitation antecedent to the sampling event that results in a marked increase in stream flow.
5. Apply the following to interpret dry weather data:
   - ≤10% of the samples exceed criteria (step 2 and 3, above) assessed as Support,
   - 11-25% of the samples exceed criteria (step 2 and 3, above) assessed as Partial Support,
   - >25% of the samples exceed criteria (step 2 and 3, above) assessed as Non-support.

AESTHETICS USE

All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life. The aesthetic use is closely tied to the public health aspects of the recreational uses (swimming and boating). Below is an overview of the guidance used to assess the status (support, partial support, non-support) of the aesthetics use.

Variable (# indicates reference)	*Support*— 1.No objectionable bottom deposits, floating debris, scum, or nuisances; 2. objectionable odor, color, taste or turbidity, or nuisance aquatic life	*Partial Support* – Objectionable conditions neither frequent nor prolonged	*Non-support* – Objectionable conditions frequent and/or prolonged
Aesthetics (3)* Visual observation (4)	Criteria met (Table 3)	BPJ (spatial and temporal extent of degradation)	BPJ (extent of spatial and temporal degradation

For lakes, the aesthetic use category is generally assessed at the same level of impairment as the more severely impaired recreational use category (primary or secondary contact).

SHELLFISHING USE

This use is assessed using information from the Department of Fisheries, Wildlife and Environmental Law Enforcement's Division of Marine Fisheries (DMF). The information is in the form of various classifications of shellfish closures and restrictions. Shellfish areas under management orders are *not assessed*.

Variable (# indicates reference)	*Support* – SA Waters—open for shellfish harvesting without depuration (Open areas) SB Waters—open for shellfish harvesting with depuration (Open, conditionally approved, restricted areas)	***Partial Support*** – SA Waters—Seasonally closed, seasonally open, conditionally approved,conditionally restricted SB Waters—Seasonally closed, seasonally open, conditionally restricted areas	***Non-support*** – SA Waters—Closed areas SB Waters—Closed areas
Division of Marine Fisheries Shellfish Project Classification Area Information (11)	Reported by DMF	Reported by DMF	Reported by DMF

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CHARLES RIVER WATERSHED DESCRIPTION AND CLASSIFICATION

DESCRIPTION*

The Charles River Watershed (Figure 5) is geographically and economically a vital part of the largest employment and population complex in New England. The watershed contains all or portions of five cities and thirty towns. Extending inland from Boston Harbor southwesterly toward the Massachusetts-Rhode Island border, the Charles River Watershed has an hour-glass shape which encompasses 307square miles. The River meanders approximately 80 miles from its headwaters to its mouth.

Figure 5. Location of Charles River Watershed.

Originating at an elevation of 500 feet, the Charles River rises from springs on the southerly slope of Honey Hill about a mile from Hopkinton Center. One mile downstream and nearly 150 feet lower is Echo Lake, often referred to as the source of the Charles. The upper third of the Charles River Watershed is largely rural in character and some agriculture is still being practiced. Terrain in the upper watershed is generally gently rolling to hilly, with the highest altitudes approaching 500 feet. The eastern and southern section of the upper watershed is characterized by rolling topography with extensive swampy areas. The combination of moderate slopes, sandy pervious soil, extensive wetlands, small mill dams, and lake storage contribute to making the upper section of the river unusually slow in responding to heavy rains.

The upper area of the Charles River Watershed extends from Echo Lake to Populatic Pond on the Franklin-Norfolk town line. In the upper watershed, the Charles River covers approximately 20 miles and falls around 220 feet. Nine dams, many of which were built by riparian mill owners for power sources, interrupt the mainstem flow. The environs are largely woodlands interspersed with small manufacturing towns and farms. The 12 miles between Populatic Pond and Route 27 embrace the largest Charles natural valley storage area, the so-called "marshes" of the Upper Charles. In this and the next two downstream reaches, the river flows at very low gradient – an average of only one-foot fall per mile. As an area of natural flood-water storage and wildlife habitat, this reach retains runoff from snow-melt and storm events and substantially reduces flood flows in the river. Below Route 27 to the South Natick Dam, the wide marsh area narrows and pine-forested banks rise abruptly from the river shore. These six miles of riverway are largely in estate or trust ownership.

The middle third of the Charles River Watershed includes the area between the outlet of Populatic Pond and the South Natick Dam. This area is suburban and less populated and developed than the lower Charles. The secluded estate character of the river upstream of the South Natick Dam changes gradually from suburban land, then to sweeping lawns and finally to urban development as the river approaches the Silk Mill Dam at Hemlock Gorge in Newton/Needham. In this 11-mile stretch lies the second largest natural valley storage area—"The Dedham Loop"—and the Mother Brook Diversion (capable of diverting up to one-third the flow of the Charles to the Neponset River).

From the Silk Mill Dam to the Watertown Dam, the Charles River drops 75 feet in 10 miles, principally at seven dam sites. Within this reach one finds sharp contrasts in the aesthetic quality of the riverscape.

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* [Adapted from: *Charles River Massachusetts Study Main Report & Attachments* (Department of the Army New England Division Corps of Engineers, September 1972)]

Upstream of the Moody Street Dam, the river meanders through the Lakes District. Downstream of Moody Street, the river becomes channelized as it flows through a much more urbanized portion of the watershed.

The lower third of the watershed extends from the South Natick Dam to the New Charles River Dam. This area forms a large segment of the Boston urban complex and is densely populated and intensively developed except for several major public or semi-public reservations. This lower segment has hydrologic conditions that differ substantially from the remainder of the watershed. During periods of high precipitation, a large portion of the precipitation runs off this urbanized area into the River within a very short period of time. Normally, the high run off rate would not create any drastic problems however the hydraulic situation is complicated by fact that the Charles River empties into a harbor which at high tide is higher than the level of the Charles River.

The river downstream of the Watertown Dam, known locally as "the Basin", is formed by the Charles River Dam located 1.2 miles above the mouth of the river. The Basin is 8.6 river miles long and covers some 675 acres at its design water service level of 2.38 feet above mean sea level. The major portion of the Basin downstream of the BU Bridge has a length of 2.6 miles and widths varying form 300 to 2,000 feet; the latter width prevails throughout the central 1.5 miles of this reach.

The volume and configuration of the Charles River has been greatly modified by two factors, 1) the numerous dams which widen the mainstream and slow its pace, and 2) the extensive natural storage provided by wetland areas in the middle and upper watershed. Flood peaks in these areas are so retarded in natural valley storage areas that they do not reach the Lower Charles until three to four days after the flood peak generated downstream has passed. And, not only do upstream wetlands buffer the effects of high flow periods, they also mitigate the consequences of low flow and extended drought. By releasing their stored waters gradually in the summer months, stream flows are sustained through periods of low precipitation.

CLASSIFICATION

Consistent with the National Goal Uses of "fishable and swimmable waters", the classification of the Charles River according to the SWQS, is as follows (MA DEP 1996):

- *Class A (Public Water Supply)* from the outlet of Echo Lake, Hopkinton to Dilla Street, Milford.
- *Class B, Aquatic Life* from Dilla Street in Milford to the Milford Wastewater Treatment Plant (WWTP) discharge, Hopedale/Milford.
- *Class B, Warm Water Fishery* from the Milford WWTP discharge to the Watertown Dam, Watertown.
- *Class B, Variance granted for Combined Sewer Overflows (CS0s)* from the Watertown Dam to the Science Park Dam (Science Museum), Boston. (Note: this segment should be extended to the New Charles River Dam, Boston through the next triennial review of the Water Quality Standards).

The designation of ORW is applied to those waters with exceptional socio-economic, recreational, ecological and/or aesthetic values. ORWs have more stringent requirements than other waters because the existing use is so exceptional or the perceived risk of harm is such that no lowering of water quality is permissible. ORWs include certified vernal pools and all designated *Class A Public Water Supplies*, and may include surface waters found in National Parks, State Forests and Parks, Areas of Critical Environmental Concern (ACEC) and those protected by special legislation (MA DEM 1993). Wetlands that border ORWs are designated as ORWs to the boundary of the defined area. In the Charles River Basin, all designated ORWs are associated with *Class A Public Water Supplies* (Rojko *et al.* 1995).

Class A waterbodies in the Charles River Watershed include the following:

- Stony Brook Reservoir (Turtle Pond): source to outlet in Waltham and those tributaries thereto,
- Cambridge Reservoir: source to outlet in Waltham and those tributaries thereto,
- Sandy Pond (Flint's Pond): source to outlet in Lincoln and those tributaries thereto,
- Echo Lake: source to outlet in Hopkinton and those tributaries thereto, and
- Louisa Lake: source to outlet in Milford and those tributaries thereto.

The following tributaries (listed in the SWQS) to the Charles River are classified as follows:

- Muddy River, entire length, *Class B (CSO), Warm Water Fishery, Variance granted for CSO*

- Mine Brook, entire length, *Class B, Warm Water Fishery, High Quality Water* (note: Franklin WWTP tied into Medway (CRWPCD) on 15 January 1980)
- Sugar Brook, entire length, *Class B, Warm Water Fishery*

Unlisted waters not otherwise designated in the SWQS, are designated *Class B, High Quality Waters.* Where fisheries designations are necessary they shall be made on a case-by-case basis.

REVIEW OF EXISTING CONDITIONS AND PERCEIVED PROBLEMS

A review of Charles River Watershed data (both historical and current) from reliable sources, both internal (DEP) and external, is presented below.

STATE SURVEYS

Water Quality--The DEP has conducted numerous water quality surveys in the Charles River Watershed since 1968 (MA DEP 1999a). Prior to 1997, the most recent completed survey was the *1990 Charles River Bacteria Study* (Webber 1991). The Charles River receives three NPDES municipal discharges, all in the upper/mid watershed. In addition, three minor NPDES facilities discharge to the Stop River. The majority of the municipal wastewater from the lower Charles River Watershed is treated at Massachusetts Water Resources Authority's (MWRA) Deer Island WWTP and is discharged into Boston Harbor. Numerous other NPDES discharges (e.g., contact and non-contact cooling water, site remediation wastewater, stormwater) are located throughout the basin.

While water quality degradation in the upper/middle Charles River Watershed primarily results from municipal wastewater discharges; the numerous combined sewer overflows, stormdrains, illicit sewer connections (dry weather stormdrain discharges), and other nonpoint source inputs impact water quality in the lower portion of the basin. The 1990 study found that except for occasional fecal coliform violations and frequently high phosphorus concentrations, Charles River water quality appeared good relative to previous surveys. The worse water quality was always found at the Watertown Dam in Watertown. Notably high concentrations of bacteria were also found in the river at Moody Street in Waltham.

Water quality degradation resulting from stormwater and CSO discharges in the lower Charles River has been the subject of study by the MWRA over the past several years. The final CSO Facilities Plan/Environmental Impact Report was issued on 31 July 1997 (Metcalf & Eddy Consulting Engineers 1997). There are 19 existing permitted CSO discharges to the Lower Charles Basin (defined as the segment from the Watertown Dam to the New Charles River Dam just downstream of Science Park). Of these discharges, five are permitted to the City of Cambridge, five to the Boston Water & Sewer Commission, one to the City of Somerville, and eight to the Massachusetts Water Resources Authority. All of the discharges are untreated with the exception of discharges from the Cottage Farm CSO treatment facility (MWR 201). Among the findings in the MWRA CSO Facilities Plan was that stormwater loads are the predominant source of pollutants in the Lower Basin. Water quality monitoring by MWRA and the Charles River Watershed Association has supported this finding.

The tributaries sampled in 1990 appeared to be more degraded than the mainstem with elevated levels of solids, chlorine, nitrogen, and bacteria. These tributaries may be contributing to some of the high bacteria concentrations found in the mainstem Charles River.

Water Quantity-- The potential for low flow in the Charles River and its tributaries, and some declining surface water levels in this area has generated concern among towns, agencies, and citizens. The Department's Drinking Water Program (DWP) convened the Upper Charles River Study (Bouck 1997) to investigate water use in the towns of Franklin, Norfolk, Medway, and Millis, all of which are located near the head of the Charles River proximal to Interstate 495. Franklin is presently experiencing one of the largest population growth rates in the State. The aquifers of the area are generally unconfined with some local areas exhibiting confining conditions. Therefore, the surface water features such as streams, rivers, lakes, and ponds are in direct hydraulic connection with the permeable material that provides water to the public water supplies. As a result, water withdrawals that significantly lower the water table can potentially lower adjacent surface water features, and thereby adversely impact wildlife, aquatic habitat, and other water supplies (Bouck 1997). The

primary aquifers supplying Franklin are presently stressed to the point where future resource planning is essential for the Town to maintain its present growth rate.

The principle aquifers being stressed are along Mine Brook in Franklin, Mill River adjacent to the Franklin/Norfolk border, and the Populatic Pond/Charles River area near the juncture of Franklin, Norfolk, Medway, and Millis. Preliminary data analyzed by the Massachusetts Department of Environmental Management (DEM) found that groundwater withdrawals from these four towns has had no significant impact on the Charles River as a whole. This is most likely due to return flow from on-site septic systems and a regional wastewater treatment facility in Medway. However, the portion of the river located between the confluence of Mine Brook and the Charles River, and the wastewater treatment plant downgradient of Populatic Pond, has been impacted by the combined withdrawals along Mine Brook, Mill River, and Populatic Pond/Charles River. According to the DWP report, these stressed areas may be unable to handle any future withdrawals without adversely impacting resident aquatic communities.

Lakes, Ponds & Impoundments—The majority of the lakes, ponds, and impoundments in the Charles River Watershed were "not assessed" since water quality data were too old to make valid assessments.

Fish Toxics—At the request of a concerned citizen, DEP DWM sampled fish on 10 August 1994 from the Charles River between the South Natick Dam and Chestnut Street in Needham. The outcome of this survey resulted in the Department of Public Health (DPH) issuing a consumption advisory due to elevated levels of PCB in carp (DPH 1998). The following year, at the request of DEP's Bureau of Waste Site Cleanup, DWM sampled fish from three stations in the lower Charles River area downstream of Needham. The majority of properties along the lower Charles are zoned for either commercial or industrial use. There is also one Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) cleanup site (US Army Materials Technology Laboratory) located approximately 1.25 miles downstream from the Watertown Dam. In addition, there are numerous State regulated waste disposal sites, combined sewer overflows, and permitted as well as illegal discharges of potentially contaminated wastewater. Fish samples were collected during November of 1995. Subsequent to the evaluation of those results, the DPH extended the consumption advisory in May of 1996 from Needham downstream to the Museum of Science dam in Boston/Cambridge due to the persisting, elevated levels of PCB's in carp (DPH 1998).

Two ponds in the Charles River Watershed were included in the 1996 Public Request, Fish Toxics Monitoring Survey. Hardy Pond in Waltham was sampled on 1 July 1996 and Lake Winthrop in Holliston was sampled on 1 October 1996. The analytical results of fish collected from these stations have been evaluated by the DPH during the winter of 1996. Although mercury values in some of the fish samples from Lake Winthrop exceed the trigger level of 0.50 mg/kg, a consumption advisory has not yet been issued, however, an advisory based on high dioxin concentrations discovered in fish sampled in 1984 remains in place.

Fish from the following waterbodies have also been sampled for metals, PCB's and organochlorine pesticides in the past by DEP and results reviewed by the DPH (1998):

1986 – Echo Lake, Hopkinton – Elevated mercury concentrations in fish were revealed, however the pond has restricted access and a "NO FISHING" provision, therefore no advisory was issued.
1988 – Lake Waban, Wellesley, and Box Pond in Bellingham – No DPH advisories issued.
1989 – Cedar Swamp Pond, Milford & Sandy Pond, Lincoln – No DPH advisories were issued upon initial evaluation of the data sets for these ponds, however, in 1994 the DPH revised the criteria for advisory issuance. The trigger level for mercury concentrations in fish flesh changed from 1.0 mg/kg to 0.50 mg/kg. Subsequent to that change, data sets from these ponds were re-evaluated and a consumption advisory was issued for Cedar Swamp Pond.
1990 – Muddy River, Boston – DPH issued a consumption advisory based on elevated PCB's in several of the species collected.

Based on these data, DEP DWM recommended that collection efforts be conducted upstream to determine the extent of contamination causing body burdens of toxics in fish flesh that exceed the DPH's criteria for human edibility (MA DEP 1998b).

Benthic Macroinvertebrate Biomonitoring--Macroinvertebrate Rapid Bioassessment (MRB) was conducted by DEP in the Charles River downstream of the Milford WWTP in two successive years (1987/1988) in conjunction with physico-chemical sampling (MA DEP 1998b). The objectives were to evaluate the status of water quality and to document any improvements resulting from upgrades to the treatment plant, which began providing advanced waste treatment during the fall of 1986. Conclusions are as follows: In 1987 the benthic community downstream of the Milford WWTP was found to be severely impaired--the scarcity of aquatic macroinvertebrates in the MRB sample suggested the presence of a toxicant. Chemical data showed high instream concentrations of ammonia, implicating its role as a toxicant. Because the community was dominated by organisms tolerant of conventional pollution, it was evident that oxygen levels were also a problem for aquatic life. Dissolved oxygen (DO) concentrations in this section of the river were indeed low during the summer months of 1987. In 1988, the MRB found improved instream conditions. Concurrently, instream concentrations of ammonia-nitrogen were greatly reduced. Dissolved oxygen, however, continues to be a problem for aquatic life as evidenced by the 1988 MRB and DO data.

OTHER SURVEYS

Milford Power Limited Partnership (MPLP), formerly owned by ENRON, and currently owned by American National power, began power generation on 1 July 1994 and has continued on a regular basis since that date. During facility operation, the cooling towers are generally supplied with treated wastewater diverted from the Milford WWTP facility. The Charles River Monitoring Project, called for in the DEP Sewer Extension Permit (MA24633) was issued to MPLP on 1 April 1992. As required in the permit, water quality, habitat, streamflow and biological monitoring is routinely conducted and provided to DEP in the form of monthly and annual reports by ENSR Consulting and Engineering (ENSR 1998). Procedures followed are defined in the Quality Assurance Project Plan (ENSR 1992) for the Charles River Monitoring Project.

Camp Dresser & McKee (CDM) has recently surveyed (1996-1997) a portion of the Charles River Watershed as part of a wasteload allocation study for the Charles River Pollution Control District (CDM 1997). Sampling was conducted in the Charles River between Populatic Pond and the Cochrane Dam in Dover, as well as in some of the larger tributaries in this portion of the basin.

The Charles River Watershed Association (CRWA) conducted extensive monitoring activities from 1995-1997 as part of their Integrated Monitoring, Modeling, and Management Project (CRWA 1995; CRWA 1997a and b; CRWA 1998; CRWA 1999 and Lancaster *et al.* 1995)—herein referred to as IM3 Project, which was initiated in 1994. Water quality sampling was conducted monthly at 37 mainstem stations as well as numerous tributaries throughout the watershed. Agencies participating in the IM3 project included both the EPA and Brandeis University.

The BSC Group-Boston, Inc. conducted water quality monitoring in Populatic Pond, Medway as part of their Populatic Pond Diagnostic/Feasibility Phase I Study (1988). The study summarizes the physical, chemical, and biological character of the Pond, identifies sources of nutrients and pollution that may be contributing to degradation, and recommends measures to restore and enhance water quality conditions in Populatic Pond.

The Metropolitan Area Planning Council (MAPC) developed a Water Supply Protection Plan for nine communities in the upper Charles River Basin (1993). The plan (Volume I and II) includes: an inventory of the communities' water resources incorporating watershed and aquifer recharge areas; inventory of land uses and potential sources of contamination; analysis of local zoning and water resource protection and recommendations for additional water supply protection.

Plexus Scientific Corporation has prepared a Supplemental Phase 2 Remedial Investigation (RI) Report and an Aquatic Ecological Risk Assessment Report (PLEXUS 1996) for a portion of the Charles River adjacent to the U.S. Army Materials Technology Laboratory (AMTL) in Watertown. Sediment sampling and benthic macroinvertebrate surveys were conducted at numerous stations in the Charles River in the vicinity of the AMTL.

MWRA's Monitoring of Boston Harbor and its tributaries includes studies on water quality (1993-present), macroalgal growth, hydrographic data in the Inner Harbor, CSO receiving waters and anthropogenic virus monitoring. The water quality monitoring began in 1993 to document water quality changes as pollution

abatement projects are implemented. The data were collected Harbor-wide and in the Charles, Mystic and Neponset Rivers at five stations year round. Additionally in 1998 there was a focus on the Charles River with two water quality monitoring stations (Watertown Dam and Science Museum Dam) sampled weekly year-round with an emphasis on eutrophication. During the 1998 focus on the Charles, CSO Receiving Water Monitoring included 14 locations from Watertown Dam to Charles River Dam and one below the Charles River Dam, three times a week, every five weeks, year-round, focusing on bacteria, hydrographic data, and its relationship to rainfall (Rex 1999).

In 1987 Gale Associates began a year-round diagnostic feasibility study of Box Pond to characterize existing water quality conditions; identify and quantify nutrient and pollutant sources; and recommend pollution control measures. Phosphorus loadings to the pond were evaluated and control strategies were recommended (Hendrickson 1990).

The United States Army Corps of Engineers New England Division (NED) conducted a Water Resources Study of the Muddy River Watershed in 1992 (1992). Findings of this study were developed after a review of existing water quality reports for the basin, and based on sediment and water quality analysis performed by the Corps of Engineers. A summary of reconnaissance findings is included in Appendix C of their study (U.S. Army Corps of Engineers 1992).

The United States Geological Survey conducted a study *Channel Morphology and Streambed-Sediment Quality in the Muddy River, Boston and Brookline, Massachusetts, October 1997* in support of EOEA's Muddy River Task Force (Breault *et al.* 1998). The report was prepared in cooperation with the Fenway Alliance, USEPA, MA DEM, City of Boston, Department of Parks and Recreation, Town of Brookline, Department of Public Works. The report describes the bathymetry and thickness of streambed sediment, volume of streambed sediment and occurrences/distribution of total trace metals and organic compounds in the sediment of Muddy River.

The United States Environmental Protection Agency Office of Environmental Measurement and Evaluation conducted continuous diurnal dissolved oxygen monitoring at five locations in the mainstem Charles River in support of EPA's Clean Charles 2005 Initiative and the DEP's 1997/1998 Quality Assurance Project Plan (EPA 1998).

Discharge Monitoring Reports—Four of the six municipal wastewater treatment facilities (Milford WWTP – MA0100579, Charles River Water Pollution Control District -- MA0102598, Medfield POTW—MA0100978, and Norfolk-Walpole MCI – MA0102253) are required to submit quarterly toxicity testing reports to EPA and DEP as required by their NPDES permits. Data from these reports (maintained by DWM in a database known as "Toxicity Testing Data –TOXTD") is also utilized by DEP in the assessment of water quality conditions in the Charles River Basin (Dallaire 1998).

OBJECTIVES

This report summarizes information generated in the Charles River Watershed through *Year 1* (information gathering in 1996) and *Year 2* (environmental monitoring in 1997) activities established in the "Five-Year Cycle" of the Watershed Initiative. Data collected by DWM in 1997/1998, in accordance with the Quality Assurance Project Plan (QAPP) (MA DEP 1998b), are provided in Appendix A, B, and C (QA/QC, data tables, technical memorandum of biological monitoring, respectively). Together with other sources of information (identified in each segment assessment), the status of water quality conditions of lakes and streams in the Charles River Watershed were assessed in accordance with EPA's and DEP's use assessment methods. Current activities are summarized in Appendix D. It is important to realize that not all waters in the Charles River Watershed have been assessed. Only those segments that have been surveyed at some time by DEP are included in this report.

The objectives of this water quality assessment report are to:

1. Evaluate whether or not individual segments currently meet water quality standards,
2. evaluate the status of each designated use that is applicable to the segment,

3. identify major point and nonpoint sources that could effect the segment (water withdrawals, wastewater discharges, land use practices, etc),
4. identify the presence or absence of any non-native macrophytes in lakes,
5. identify waters (or segments) of concern that require additional data to fully assess the water quality conditions, and
6. recommend additional monitoring needs and/or remediation actions in order to better determine the level of impairment or to improve/restore water quality.

SEGMENT REPORT FORMAT

The segment order in this assessment report follows the Massachusetts Stream Classification Program (Halliwell *et al.* 1982) hierarchy. Stream segments are organized hydrologically (from most upstream to downstream). Tributary summaries follow the segment into which they discharge. Lakes segment summaries are presented after the stream segments. Each segment summary is formatted as follows:

Segment identification

Name, water body identification number (WBID) (Dallaire 1999), location, length, and classification.

Sources of information: coding system (waterbody identification number e.g., MA72-01) used by DEP to reference the stream segment in databases such as 305(b) and 303(d) (Dallaire 1999), the Massachusetts SWQS (MA DEP 1996), and other descriptive information.

Segment description

Flow direction, tributary confluences, and other observations.

Sources of information: descriptive information from USGS topographical maps.

Segment locator map

Watershed map, segment origin and termination points.

Sources of information: MassGIS (EOEA 1999) data layers (stream/lake segments, and quadrangle maps).

Water withdrawals and wastewater discharge permit information

WMA, NPDES, and CSO permits.

Sources of information: WMA Database Printout (LeVangie 1997); open permit files located in Worcester, Wilmington, and Lakeville DEP Offices (MA DEP 1999b and 1999c); Department Environmental Management (DEM), MassGIS (EOEA 1995a EOEA 1995b and 1997) maps (priority resources, water supply protection, and draft active NPDES sites).

Use assessment

Discussion of current reliable data/information.

Sources of information: recent DWM survey data (Appendix A, B, and C) and the following: data from the DEP DWM Toxicity Testing Database "TOXTD" (Dallaire 1998), USGS streamflow data (Socolow *et al.* 1998, and Socolow *et al.* 1999), sources listed in the *"Other Surveys*" section of *"Review of Existing Conditions and Perceived Problems",* and the MA DPH Freshwater Fish Consumption Advisory List (DPH 1998).

Summary

Designated use status table.

Recommendations

Additional monitoring and implementation needs.

CHARLES RIVER WATERSHED - RIVER SEGMENT ASSESSMENTS

The following segments in the Charles River Watershed are included in this report (Figure 6):

CHARLES RIVER WATERSHED - RIVER SEGMENT ASSESSMENTS 18
- Charles River (Segment MA72-01) 19
- Charles River (Segment MA72-02) 20
- Charles River (Segment MA72-03) 23
- Charles River (Segment MA72-04) 26
- Beaver Brook (Segment MA72-12) 29
- Mine Brook (Segment MA72-14) 30
- Charles River (Segment MA72-05) 32
- Mill River (Segment MA72-15) 36
- Stop River (Segment MA72-09) 39
- Stop River (Segment MA72-10) 41
- Bogastow Brook (MA72-16) 43
- Charles River (Segment MA72-06) 46
- Waban Brook (Segment MA72-17) 48
- Fuller Brook (Segment MA72-18) 50
- Trout Brook (Segment MA72-19) 52
- Powissett Brook (Segment MA72-20) 54
- Charles River (Segment MA72-07) 56
- Rock Meadow Brook (Segment MA72-21) 59
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- Unnamed tributary (Segment MA72-27) 71
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- Charles River (Segment MA72-08) 76
- Unnamed tributary (Segment MA72-30) 80
- Muddy River (Segment MA72-11) 82
- Unnamed tributary (Segment MA72-31) 85

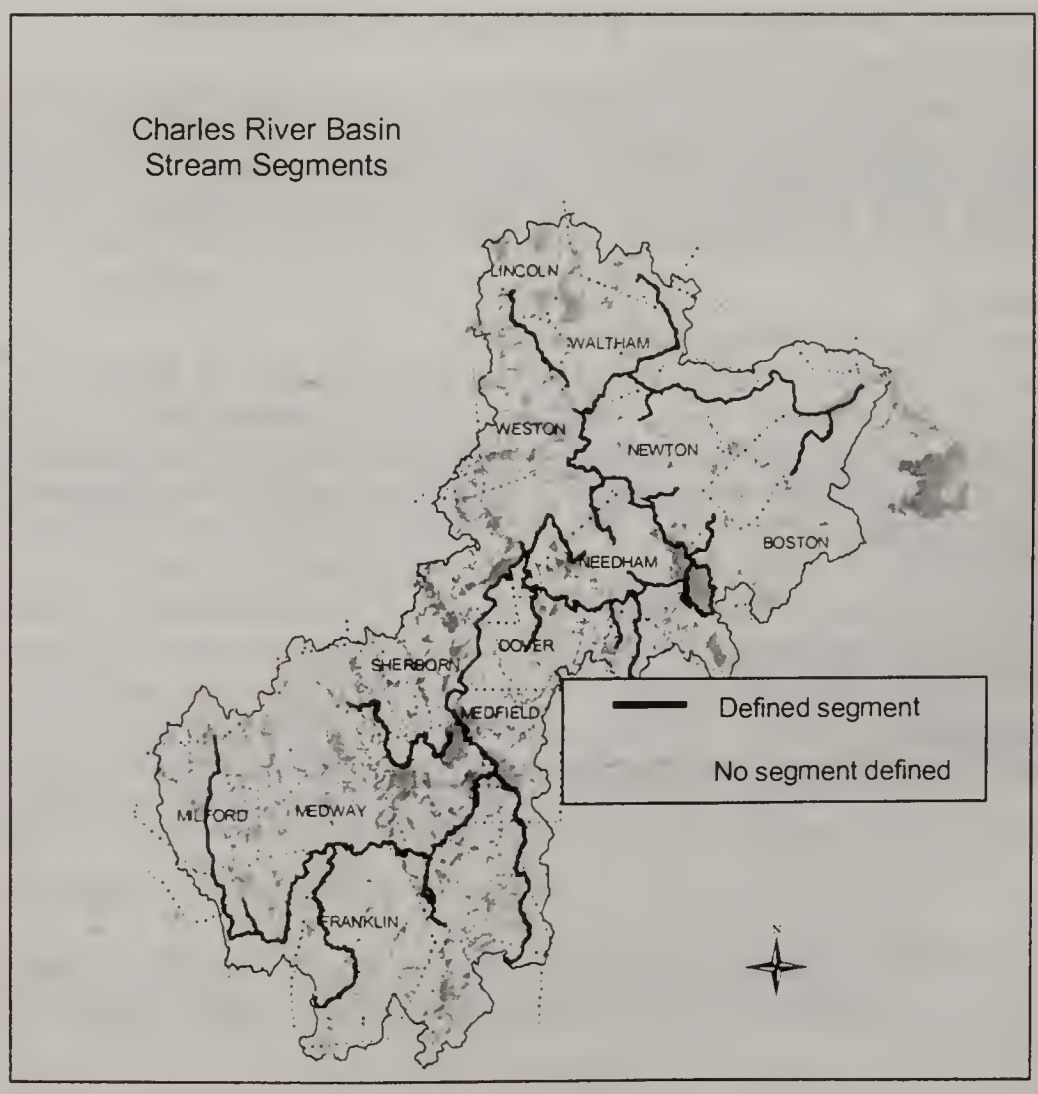


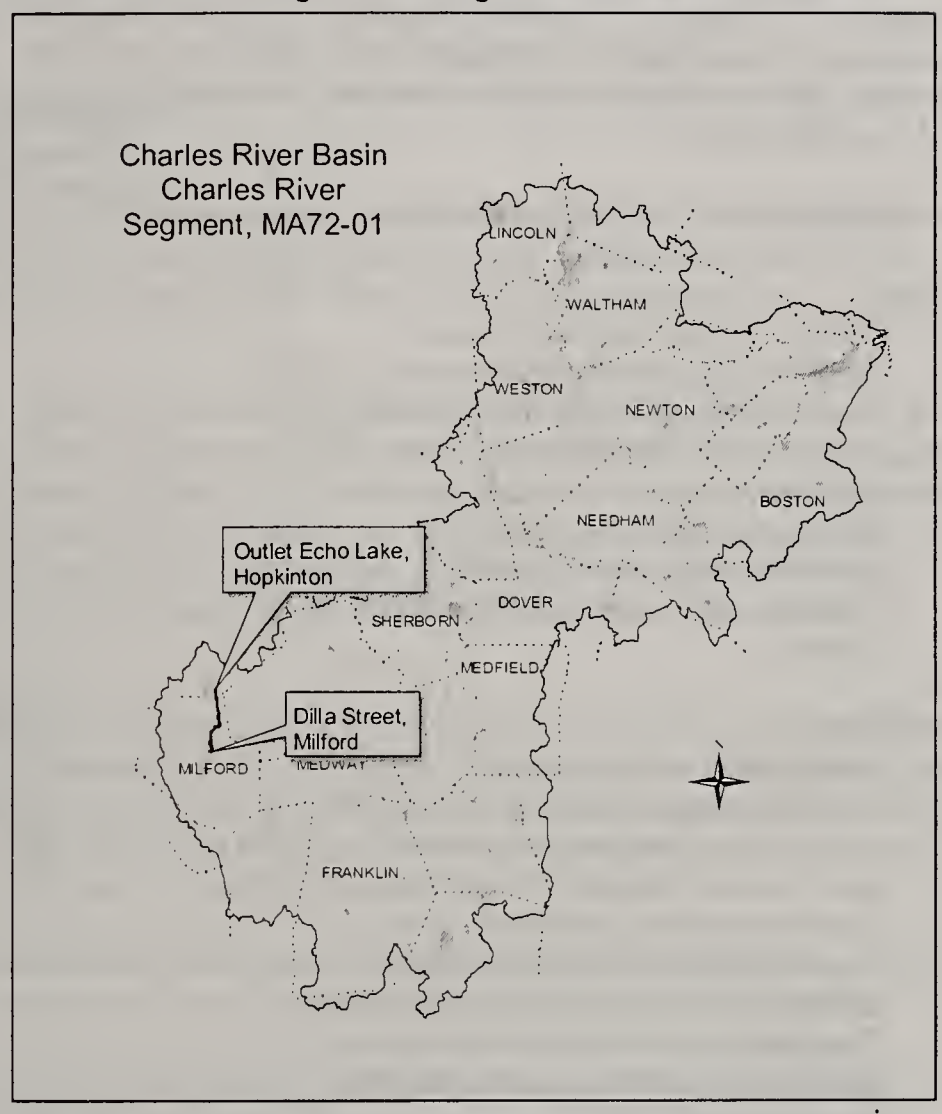
Figure 6. Charles River Watershed stream segment locations.

CHARLES RIVER (SEGMENT MA72-01)

Location: Outlet of Echo Lake, Hopkinton to Dilla Street, Milford. Segment Length: 2.47 miles
Classification: Class A, Public Water Supply, Warm Water Fishery.

SEGMENT DESCRIPTION

From the outlet of Echo Lake in Hopkinton, the Charles River flows in a southerly direction through a predominantly wooded portion of the watershed. After receiving the drainage of Wildcat Pond and an unnamed tributary, the river continues south, crossing Interstate 495 before reaching the Dilla Street road crossing in Milford.



WITHDRAWALS AND DISCHARGES

WMA:

1. Public surface water withdrawal 2185000-02S in Hopkinton; 2185000-01S in Milford
2. Public groundwater withdrawals 2185000-01G in Milford

USE ASSESSMENT

No water quality monitoring has been conducted in this upper segment of the Charles River. The Milford Water Company has a pipeline from Echo Lake to the pumping station/sand filters at Dilla Street. This segment is designated as Class A/Public Water Supply. "To the extent compatible with this use these waters shall also be an excellent habitat for fish, other aquatic life and wildlife as well as primary and secondary contact recreation" (MA DEP 1996). Field reconnaissance and observations by DEP sampling staff noted reduced (little to no) streamflows in this segment.

SUMMARY

Because of the lack of data, all designated uses (below) in the Charles River between the outlet of Echo Lake, Hopkinton and Dilla Street, Milford are not assessed at this time.

Aquatic Life	Fish Consumption	Drinking Water	Primary Contact	Secondary Contact	Aesthetics

RECOMMENDATIONS: Charles River (Segment MA72-01)

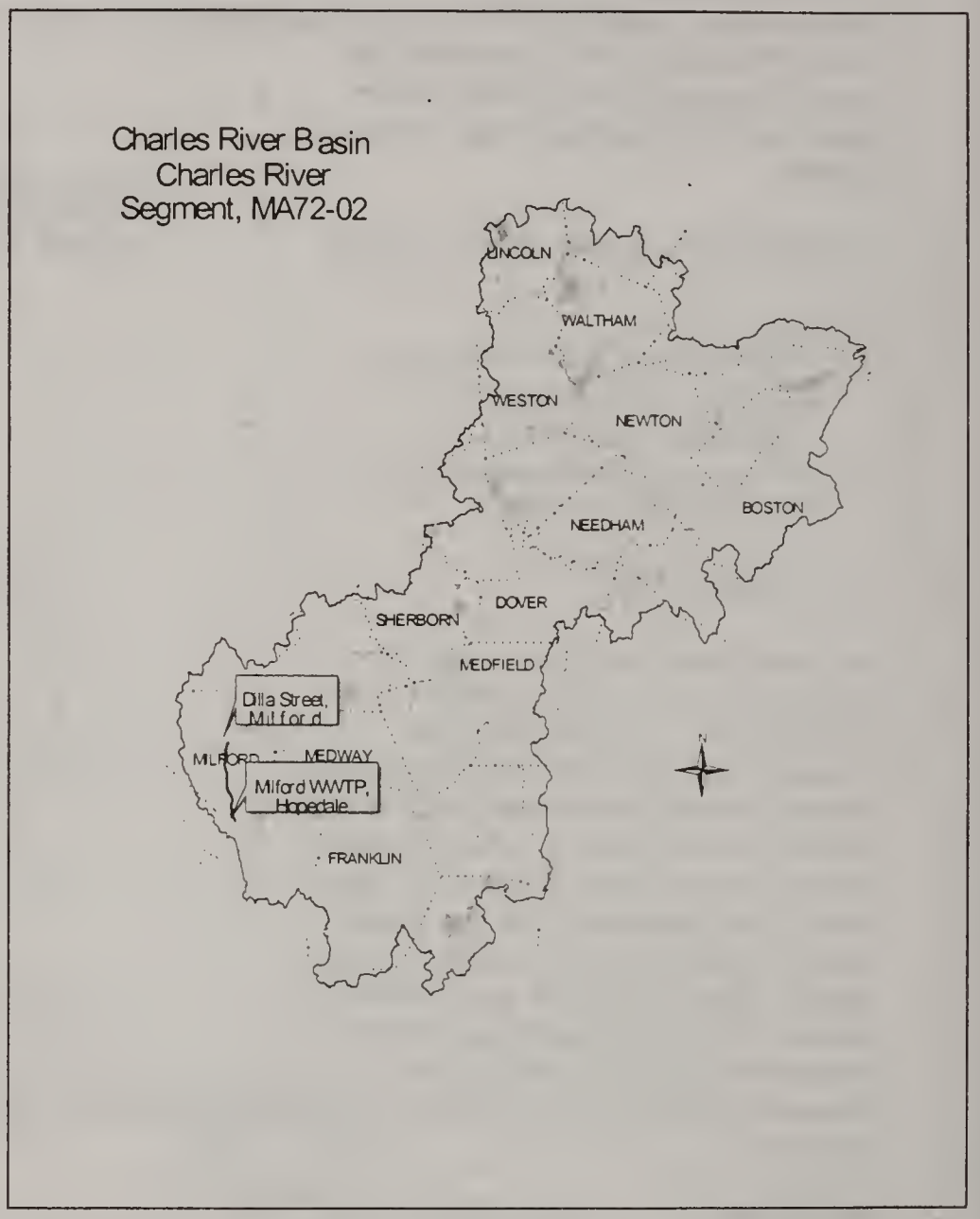
- Due to reduced flow in this segment resulting from the diverting of water via pipeline by the Milford Water Company, biological monitoring is strongly recommended to establish baseline conditions of biological integrity. The majority of this segment offers potentially excellent instream and riparian habitat for both fish and macroinvertebrates; however, reduced base flows may be detrimental to resident aquatic life (Fiorentino 1998).

CHARLES RIVER (SEGMENT MA72-02)

Location: Dilla Street, Milford to Milford WWTP, Hopedale. Segment Length: 3.1 miles
Classification: Class B, Warm Water Fishery.

SEGMENT DESCRIPTION

This segment of the Charles River flows south through Cedar Swamp Pond (a.k.a., Milford Pond). The segment continues to flow in a southerly direction, through several underground stretches in urban Milford. This segment is also joined by Godfrey Brook upstream of the Milford WWTP.



WITHDRAWALS AND DISCHARGES

WMA:

1. Public surface water withdrawal 2185000-03S from surface waters (Lousia Lake on Huckelberry Creek) that feed into this segment of the Charles River.
2. Public groundwater withdrawals: 2185000-02G, 2185000-05G, 2185000-03G, and 2185000-04G all in Milford

NPDES:

1. MA0033936 Mobil Station 06-PLH (unconfirmed). This facility has a permit to discharge effluent from a groundwater remediation project to a storm sewer that discharges into Cedar Swamp Pond (Milford Pond).
2. MA0031127 A.J. Knott Tool & Mfg. Co. This facility has a permit to discharge parking lot runoff into Cedar Swamp Pond (Milford Pond).

USE ASSESSMENT

In 1989, DWM conducted fish toxics monitoring in Cedar Swamp Pond. DPH did issue a fish consumption advisory for Cedar Swamp Pond due to elevated levels of mercury (DPH 1998). The advisory recommends that children younger than 12 years, pregnant women and nursing mothers should not eat any fish from this waterbody, and the general public should limit consumption of all fish from this waterbody to two meals per month. Therefore the fish consumption use is assessed as non-support for 1.1 miles. The capped Milford Landfill, adjacent to the shore of Cedar Swamp Pond, was issued a closure certification by DEP. This site now functions as an athletic field complex.

The IM3 Project (CRWA 1998) documented sewage discharges into the Charles River at Central Street in Milford and in Godfrey Brook. EPA is taking enforcement action to address this problem. Milford did not fully comply with the order, and subsequent sampling by CRWA confirms the fecal coliform problem still exists. Elevated fecal coliform bacteria (233 – 42,000 cfu/100ml) were also documented in the 1997 annual report by ENSR (1998) at the end of this segment (ENSR Reach 1 data). The primary and secondary contact recreational uses are non-support for the portion of the segment from East Main Street (where the stream goes underground) in Milford to the end of the segment. The upper portion of the segment, through Cedar Swamp Pond to the East Main Street bridge, is considered not assessed for the recreational uses

due to land use changes (less urbanized upper watershed) and a lack of any instream data upstream from Central Street.

DEP identified that habitat quality in this segment of the Charles River was limited with respect to the flow regimes and instream substrates. Little to no velocity was observed upstream of the Milford WWTP discharge.

Macroinvertebrate data collected in "Reach 1" (upstream of the Milford WWTP discharge) by ENSR (1998) revealed a moderately impacted benthic community. Although used as the reference condition to evaluate instream effects in the Charles River associated with the Milford WWTP/Milford Power Limited partnership facilities, the benthic community was dominated by organisms tolerant of organic pollution and associated low dissolved oxygen.

The fish assemblage (ENSR 1998) in the Charles River upstream of the Milford WWTP discharge included eight species, three of which were represented by only one individual. Many of the species present are typical of a warmwater, slow-moving stream/pond assemblage. The sample was dominated by pumpkinseed (*Lepomis gibbosus)*.

Dissolved oxygen measurements (ENSR, 1998) were frequently below the Class B, Aquatic Life, criteria during summer months between 1992 and 1995. Data from 1996 and 1997 indicate improvement (meeting criteria) in water column dissolved oxygen levels. Other water quality measurements made in the Charles River upstream of the Milford WWTP discharge by ENSR (1998) include pH, temperature, suspended solids, and ammonia nitrogen. Although pH was often lower than 6.5 SU, none of the other variables exceeded Class B criteria (there were sporadic exceedences of criteria, however none were frequent or prolonged).

Although some improvements in the water quality of the Charles River in this segment are being realized (corrective actions taken by town of Milford, improving dissolved oxygen conditions in summer months, etc.), habitat quality remains limited with respect to flow regimes and instream substrates necessary to support a diverse benthic community. This in turn is reflected in the resident biota, which continues to show signs of degradation (response) resulting from anthropogenic influences (stressors).

Based on these findings the lower portion of this segment (below Central Street, Milford) was assessed as non-support for the aquatic life use, while the upper portion remains not assessed due to lack of data.

In the lower one-third mile of the Charles River in this segment (downstream from ENSR station HA-2), the habitat assessments conducted by ENSR indicated that excessive nuisance aquatic vegetation existed instream. Therefore the aesthetic use was assessed as partial support for the lower 0.3 miles. The upstream section of this reach (2.8 miles) remains not assessed due to lack of data.

SUMMARY

Designated Uses		Status
Aquatic Life		The upper 1.2 miles of this segment are not assessed. The lower 1.9 miles do not support this use because the benthos are indicative of moderately impacted conditions.
Fish Consumption		1.1 miles (Cedar Swamp Pond) are non-support for this use due to a DPH fish consumption advisory (mercury). The remainder (2.0 miles) of the segment is not assessed.
Primary Contact		The upper 1.2 miles of this segment are not assessed. The lower 1.9 miles do not support this use because of elevated pathogen levels.
Secondary Contact		The upper 1.2 miles of this segment are not assessed. The lower 1.9 miles do not support this use because of elevated pathogen levels.
Aesthetics		The upper 2.8 miles of this segment are not assessed. The lower 0.3 miles only partially support this use due to dense nuisance vegetation.

RECOMMENDATIONS: Charles River (Segment MA72-02)

- Monitoring should be conducted in the upper reaches of this segment to establish a reference station for future biomonitoring studies in this segment of the Charles River. Habitat evaluations should accompany any biomonitoring efforts in this segment. Water quality and bacteria sampling should be conducted upstream of East Main Street, Milford (where the Charles River is culverted underground) to increase spatial coverage as well as establish baseline conditions upstream of known water quality problems.

- Continue efforts to bring Milford into compliance regarding the illicit sewer connections to the stormdrain system (Charles River at Central Street and Godfrey Brook subwatershed). The town of Milford should inspect and repair failing storm and sanitary sewer infrastructure.

- The technical advisory committee (TAC) should review and analyze results of ENSR's Charles River Monitoring Program for the Milford Power Limited Partnership facility in Milford. Permitting decisions would be made based upon the impact evaluations provided by the TAC.

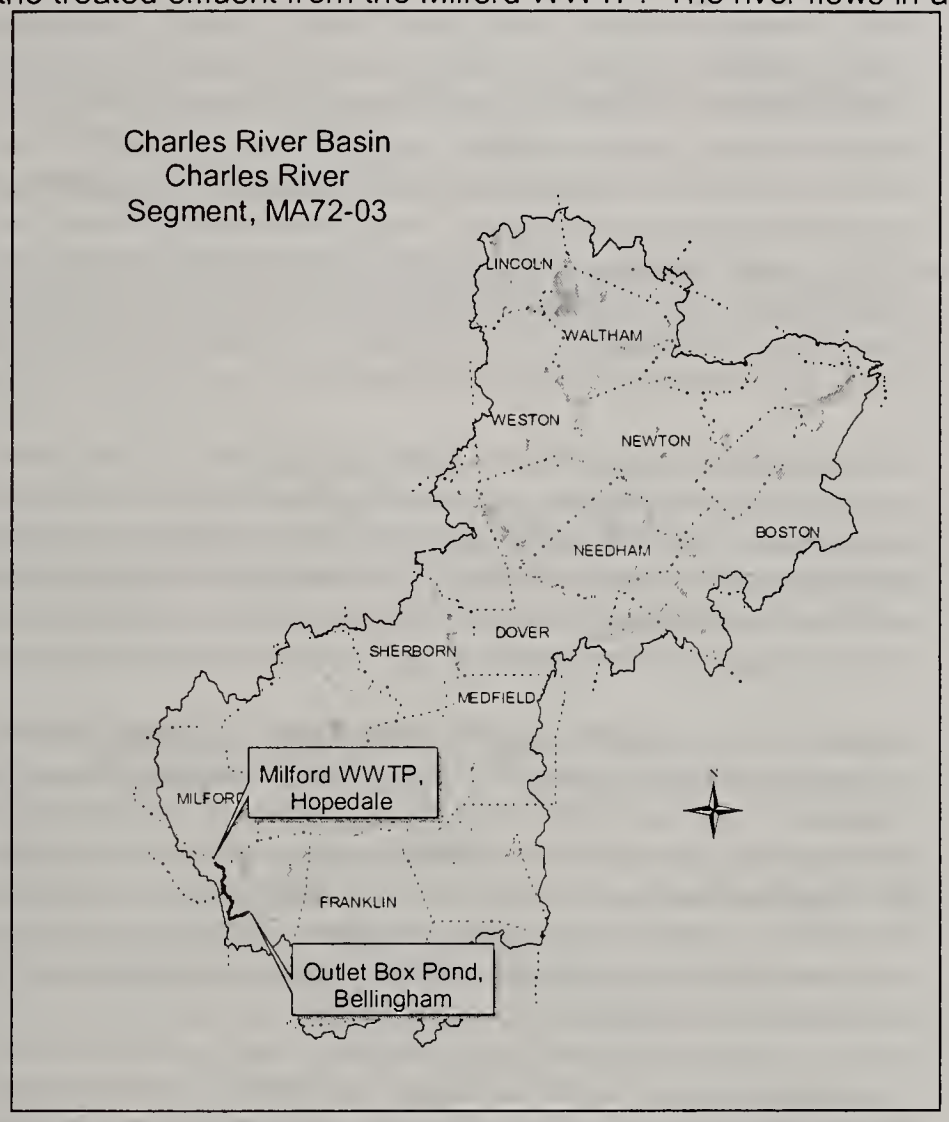
- Investigate impacts, if any, of landfill leachate and stormwater discharges on Cedar Swamp Pond.

CHARLES RIVER (SEGMENT MA72-03)

Location: Milford WWTP, Hopedale to outlet Box Pond, Bellingham. Segment Length: 3.1 miles.
Classification: Class B Warm Water Fishery.

SEGMENT DESCRIPTION

This segment of the Charles River receives the treated effluent from the Milford WWTP. The river flows in a generally southerly direction through mostly open space and light residential land use until it enters Box Pond, after which the channel turns east.



WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0100579 Milford WWTP. This facility has a permit to discharge 4.3 MGD of treated wastewater effluent directly into the Charles River.

OTHER:

1. Milford Power Limited Partnership (MPLP). Formerly owned by ENRON, and currently owned by American National Power, the MPLP facility began power generation on July 1, 1994 and has continued on a regular basis since that date. During facility operation, the cooling towers are generally supplied with treated wastewater diverted from the Milford WWTP facility. The Charles River Monitoring Project, called for in the MADEP Sewer Extension Permit (MA24633) was issued to MPLP on April 1, 1992 and amended in 1997. As required in the permit, water quality, habitat, and biological monitoring is routinely conducted by ENSR Consulting and Engineering upstream (1 sampling reach) and downstream (3 sampling reaches) of the Milford WWTP discharge. Procedures followed are defined in their QAPP (ENSR 1992) for the Charles River Monitoring Project.

2. Benzenoid Organics Hazardous Waste Site Cleanup, Mendon Road, Bellingham. Remedial actions listed as complete.

USE ASSESSMENT

The IM3 Project (CRWA 1998) has one station in this segment of the Charles River. Station 59CS is located at the Mellen Street Bridge in Bellingham. Dry weather bacteria densities ranged between 90 – 740 cfu/100ml while wet weather sampling results ranged between 90 – 9000 cfu/100ml. These data were collected monthly from June 1996 – October 1997. Elevated fecal coliform bacteria (147 – 29,000 cfu/100ml) was also documented by ENSR in their reach 2-4 data (1998). Based on these data the primary contact recreational use has been assessed as non-support for the entire length of this segment. The secondary contact recreational use, however, is partially supported since the dry weather data did not exceed 2,000 cfu/100ml. This comes from the assessment guidance where wet weather events are not considered frequent or prolonged (see use assessment methods).

Habitat quality in this segment of the Charles River improved compared to the previous segment (MA72-02) with respect to the flow regime (a result of the effluent discharge) and substrates suitable for macroinvertebrate colonization. However, sedimentation and degraded channel morphology, evidenced by substrate embeddedness and channelization, was prevalent throughout the stream reaches sampled by ENSR (1998). The estimate of the 7Q10 discharge in this segment of the Charles River for the period of record (1989-1996) was 1.18 cfs (Reis 1999).

Macroinvertebrate data collected in "Reach 2 and 3" (downstream of the Milford WWTP discharge) by ENSR (1998) revealed no impacts as compared to the reference station (Reach 1) community. The only biological attribute found to be significantly different from upstream reference conditions was the community similarity index, which may be a result of less comparable flow regimes. The benthic community found at Reach 2, similar to the upstream reference condition in terms of structure and balance, continues to show signs of moderate impairment. These impacts likely result from organic enrichment and low dissolved oxygen levels. However, biological integrity seems to show signs of gradual improvement further downstream, as evidenced by the reoccurrence of more pollution-sensitive Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) or EPT taxa, lower community dominance by one taxon, and increased community diversity in the Reach 3 macroinvertebrate assemblage.

The fish assemblage (ENSR 1998) in the Charles River downstream of the Milford WWTP continues to be dominated by warmwater, slow-moving stream/pond taxa. Diversity immediately downstream of the discharge was considerably less than those of the upstream control at FS2, with redfin pickerel (*Esox americanus*) and chain pickerel (*E. niger*) the numerically dominant species. Taxa richness increased to eight further downstream of the discharge at station FS4, where an assemblage dominated by pumpkinseed (*Lepomis gibbosus*) appeared more similar to the upstream control station.

Similar to the upstream segment (MA-7202), dissolved oxygen measurements (ENSR 1998) were frequently below the Class B, Warm Water Fishery, criteria during summer months between 1992 and 1995. Data from 1996 and 1997 indicate improvement (meeting criteria) in water column dissolved oxygen levels, although saturation was below 60% on two occasions in 1997. Other water quality measurements made in the Charles River downstream of the Milford WWTP discharge by ENSR (1998) include pH, temperature, suspended solids, and ammonia nitrogen. Although pH was occasionally lower than 6.5 SU, none of the other variables exceeded Class B criteria (there were sporadic exceedances of criteria, however none were frequent or prolonged).

The habitat assessments conducted by ENSR (1998) indicated that excessive nuisance aquatic vegetation existed instream in the reach just downstream from the POTW discharge. Elevated nutrients (nitrogen and phosphorus) were also documented by ENSR, apparently originating from both the POTW as well as upstream sources in Milford. Poor water quality and very dense mats of macroscopic algae and other aquatic vegetation observed in Box Pond are indicative of eutrophic conditions. Based on these data the aesthetic use was assessed as partial support for the entire length of this segment.

Sediment quality monitoring was conducted by EPA near the outlet of Box Pond (CRWA02) as part of the IM3 Project in May 1996 (CRWA 1997a). Despite elevated concentrations of pesticides and heavy metals (particularly copper) which exceeded L-EL guidelines, acute toxicity was not exhibited by either the midge *Chironomus tentans* or the amphipod *Hyallela azteca.*

Toxicity testing of the effluent from the Milford WWTP is required in their NPDES permit. The effluent has not exhibited any acute toxicity and the facility is usually meets their chronic toxicity limits (Dallaire 1998).

SUMMARY

Designated Uses		Status
Aquatic Life		The upper 0.4 miles of this segment do not support the aquatic life use (from the POTW discharge to Mellen St) because the benthos is indicative of moderately impacted conditions. The lower 2.7 miles partially support the aquatic life use since there appears to be a gradual recovery in biological integrity.
Fish Consumption		Not assessed
Primary Contact		The entire length of this segment is assessed as non-support due to elevated levels of pathogens.
Secondary Contact		The entire length of this segment is assessed as partial support a result of elevated levels of pathogens.
Aesthetics		Very dense nuisance vegetation in the upper 0.4 miles as well as throughout Box Pond, and less dense vegetation in the middle portion of this segment renders the entire length of this segment as partial support for this use.

RECOMMENDATIONS: Charles River (Segment MA72-03)

- Continue to review and analyze results of ENSR's Charles River Monitoring Program for the Milford Power Limited Partnership facility in Milford. The technical advisory committee (TAC) should continue to review and analyze results of ENSR's Charles River Monitoring Program for the Milford Power Limited Partnership facility in Milford. Permitting decisions would be made based upon the impact evaluations provided by the TAC.

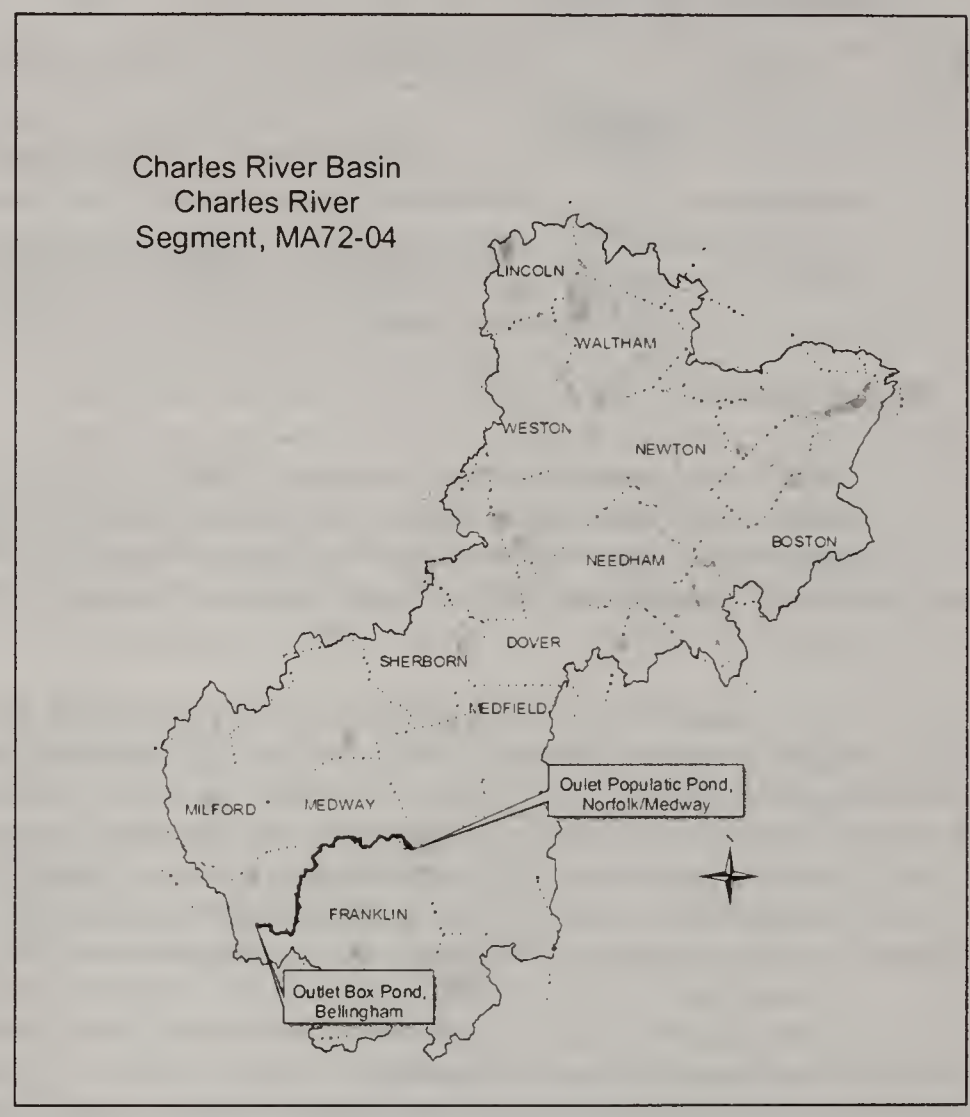
- The Gale Associates Box Pond Diagnostic/Feasibility Study Draft Final Report (Hendrickson 1990) recommendations included the following phosphorous load reductions to the Charles River and its tributaries:
  - phosphorous load reductions from stormwater runoff by incorporation structural improvements to drainage systems which maximize infiltration, in conjunction with increased roadway and catch basin cleaning, and the use of fertilizers which do not contain phosphorous;
  - phosphorous load reductions from wastewater discharges by eliminating all upstream sewer overflows and by further reduction of the phosphorous concentration of the WWTP effluent;
  - phosphorous load reductions from watershed land use activities by adopting appropriate bylaws to reduce water quality impacts.
  - Implementation of a public education program emphasizing phosphorus reduction strategies (e.g., septic systems and lawns).
  - An in-lake weed harvesting program to reduce aquatic plant biomass thereby reducing nutrient levels, increasing lake circulation, improving fishery quality, and restoring boating and aesthetic quality.

CHARLES RIVER (SEGMENT MA72-04)

Location: Outlet Box Pond, Bellingham to outlet Populatic Pond, Norfolk/Medway. Segment Length: 11.4 miles. Classification: Class B, Warm Water Fishery.

SEGMENT DESCRIPTION

This segment of the Charles River meanders east, flows north and eventually heads east again along the Medway/Franklin border. The river then flows into the northwestern corner of Populatic Pond and out the northeastern corner. This segment drains an area of considerable wetland and open space before flowing through West Medway and Medway center, where light to moderate residential and commercial land uses predominate.



WITHDRAWALS AND DISCHARGES

WMA:

1. Proposed groundwater wells #11 and #12.
2. Public groundwater withdrawal 2177000-01, 2177000-02, and 2177000-03G all in Medway.
3. Public groundwater withdrawal 4101000-08G in Franklin.

USE ASSESSMENT

The IM3 Project (CRWA 1998) has four stations in this segment of the Charles River. Station 90CS is located at Route 126 in Bellingham, 130S is at Maple Street in Bellingham, 165S at Shaw Street in Medway/Franklin and 199S at the Populatic Pond boat launch in Norfolk. DWM has one monitoring station at the lower end of this segment (CR03 at Walker Street in Medway).

Dry weather bacteria levels ranged between <10 – 36,000 cfu/100ml while wet weather sampling results ranged between 40 – 13,000 cfu/100ml. These data were collected in June and July 1995 and monthly from July 1996 – April 1998 (see CRWA IM3 Project: Lancaster *et al.* 1995 and CRWA 1998). DEP DWM fecal coliform counts fell within the range identified by CRWA (Appendix B, Table B5). Based on these data the primary contact recreational use has been assessed as non-support (10/53 bacteria samples collected under dry weather - 19% above 400 cfu/100ml and 9/39 or 23% of the samples collected under wet weather) for the entire length of this segment. The secondary contact recreational use, however, is partially supported since infrequent 4/87 or 5% of the samples collected under dry weather conditions exceeded 2000 cfu/100ml and 3/52 or 6% of the samples collected under wet weather conditions exceeded 4000 cfu/100ml (Assessment Methodology).

Stream discharge measurements in this segment of the Charles River were collected between June 1997 and December 1997. The discharge ranged between 6.57 and 54.6 cfs (Appendix B, Table B2).

Dissolved oxygen was recorded by DWM using a Hydrolab™ multiprobe analyzer. These *in-situ* measurements made in the Charles River at Walker Street in Medway (CR03) were all at/above 7.7mg/L and 88% saturation (Appendix B, Table B3). These data, however, were not collected before dawn and therefore do not represent worst case conditions. Temperature, suspended solids, and ammonia nitrogen

(Appendix B, Tables B3 and B4) were all within Class B standards (Table 3) although pH was occasionally lower than 6.5 SU. Based on these data, water quality in this segment of the Charles River appears to be fairly good.

The EPA collected continuous DO, temperature, and pH measurements during the week of 11 August 1997 at upstream of Populatic Pond (station CONT01) using a YSI 6000 sonde (EPA 1998). DO data from this instrument (low of 3.52 mg/L at 2100 hours, high of 7.04 mg/L at 0445 hours) are reported as estimated. Field comparison, at two different times, indicate YSI 6000 readings to be approximately 1 mg/L lower than an adjacent YSI 57 field meter also deployed by EPA. Because these data did not follow the expected pattern (afternoon peak and morning sag) and were estimated; EPA recommended additional DO monitoring studies.

Macroinvertebrate biomonitoring was conducted in this segment on 9 July 1997 by DWM (Appendix C). The CR03 macroinvertebrate sampling reach began approximately 200m downstream from Walker Street in Medway. Habitat assessment in this portion of the river found instream substrates and flow regimes to offer excellent habitat for macroinvertebrates, with an abundance of rocky substrates subjected to varying velocity/depth combinations. Both stream banks were well-vegetated and stable, although small patches of "Japanese Bamboo" along the left bank suggest past disturbances. A relatively undisturbed riparian zone predominated on the right bank, while commercial development encroached somewhat along the left bank. Nevertheless, nonpoint source pollution inputs seemed minimal from both banks, and the road crossing just upstream from the sample reach showed little indication of gross nonpoint source impacts to the downstream aquatic community. CR03 received a habitat assessment score of 149 out of a possible 200. This station was designated an upstream reference station for CR04, which was established further downstream and downgradient of the Charles River Pollution Control District's (CRWPCD) regional wastewater treatment facility in Medway. In addition to bracketing the discharge effects of the CRWPCD discharge, CR03 was used as a reference station for the CR00 biomonitoring station in the lower Charles River Basin. The designation as reference station at CR03 was based on the habitat evaluation conducted there, surrounding land use, and overall water quality relative to the watershed. Because CR03 is the reference station, it cannot yield a final impairment score. However, the metric values calculated as part of the RBPIII analysis reflect a healthy benthic community one would expect to find in a "least impacted" stream. In particular, those parameters that measure components of community structure (taxa richness, biotic index, and EPT index)—which display the lowest inherent variability among the RBP metrics used—scored well and corroborate the designation as a reference station. CR03 received a total metric score of 40 out of a possible 42.

The DPH issued a fish consumption advisory because of elevated concentrations of mercury in largemouth bass (*Micropterus salmoides*) in the Charles River between the Medway Dam, Medway and the South Natick Dam, Natick (DPH 1998). Because of this advisory, the fish consumption use is non-support for the lower 1.9 miles of this segment. This use is considered not assessed in the upper 9.5 miles.

SUMMARY

Designated Uses		Status
Aquatic Life		The aquatic life use is not assessed for the upper 4.2 miles of the segment. The use is supported for the lower 7.2 miles of this segment since the biological integrity of the Charles River at Medway, considered to be representative of this segment, appears excellent.
Fish Consumption		The upper 9.5 miles are not assessed while the lower 1.9 miles do not support this use since DPH issued a fish consumption advisory because of elevated mercury in largemouth bass.
Primary Contact		The entire length of this segment does not support this use because of elevated levels of pathogens.
Secondary Contact		The entire length of this segment partially supports this use because of elevated levels of pathogens.
Aesthetics		Like the aquatic life use, the upper 4.2 miles are not assessed while in the lower 7.2 miles instream habitat quality appeared excellent and is therefore assessed as support.

RECOMMENDATIONS: Charles River (Segment MA72-04)

- Conduct biological assessments (macroinvertebrate biomonitoring and habitat evaluation) and diurnal oxygen measurements to better evaluate the aquatic life use in the upper portion of this segment.

- Continue to implement recommendations made by BSC (1988) to reduce eutrophication in Populatic Pond:
  Watershed Pollution Abatement Management Strategies:
  1. Land Use Regulations aimed at preserving open space or forestland along the perimeter of Populatic Pond,
  2. Zoning bylaws adjacent to waterbodies aimed at increasing the building setback from the waterbody for future construction or requiring that nonconforming uses meet the increased standards. The report regarded this strategy as ineffective. The idea of zoning a Lakefront District including all land within 1000ft of the Pond is offered,
  3. Board of Health Regulations--A septic system inspection and maintenance program is outlined, and
  4. Wetlands Protection--In a regulatory capacity, the Conservation Commission may require that certain runoff quality and quantity criteria are met, or that erosion control measures are established.

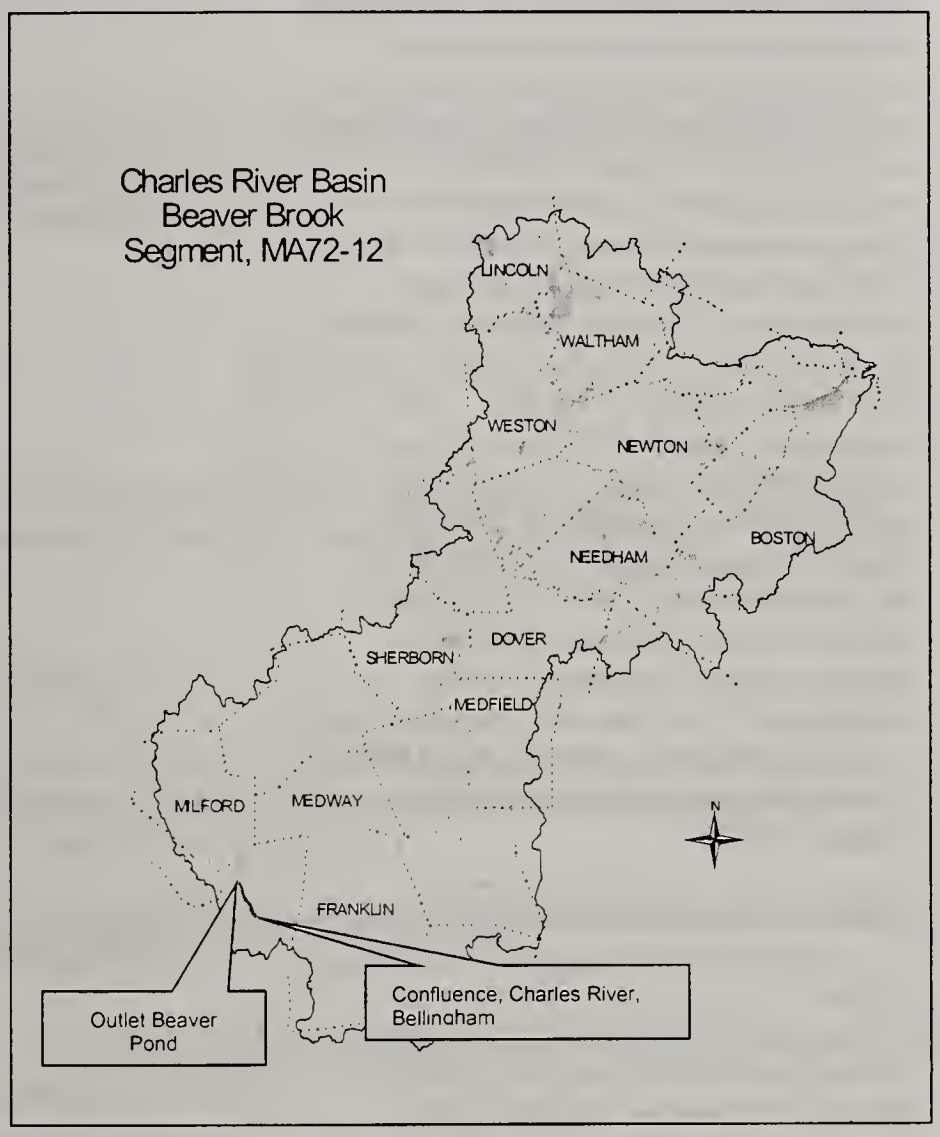
  Recommended Management Plan of Non-Point Source Pollution
  1. Create an artificial wetland system to treat stormwater runoff,
  2. Use sediment catch basins and grease/oil traps,
  3. Use leaching catch basins or galleries, infiltration trenches, or porous pavement to reduce stormwater runoff flow rates and pollutants and allow for ground water recharge,
  4. Discharge road runoff into wetland areas or wet bottom detention/retention basins,
  5. Use effluent treatment detention structures using devices designed to filter the first one-half inch of stormwater runoff. Systems may be retrofitted into existing drainage works requiring routine maintenance, and
  6. Increase street sweeping of roads adjacent to the Charles River and its tributaries. A vacuum-type street cleaning is recommended on a biweekly schedule.

BEAVER BROOK (SEGMENT MA72-12)

Location: Outlet Beaver Pond, Bellingham to confluence with Charles River, Bellingham. Segment Length: 1.7 miles. Classification: Class B, Warm Water Fishery.

SEGMENT DESCRIPTION

From the outlet of Beaver Pond in Bellingham, Beaver Brook flows in a southeasterly direction until it joins the Charles River downgradient of Box Pond. The stream drains an area of mostly open space, wetland and light residential land use.



WITHDRAWALS AND DISCHARGES

WMA:
1. Public groundwater withdrawal 2025000-05G in Bellingham

USE ASSESSMENT:

No monitoring has been conducted in this stream segment, therefore all uses are considered not assessed. A synoptic survey of Beaver Pond was conducted by DWM, and results can be found in Appendix B, Table B8.

SUMMARY

All designated uses (below) in Beaver Brook are not assessed at this time.

Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics

RECOMMENDATIONS: Beaver Brook (Segment MA72-12)

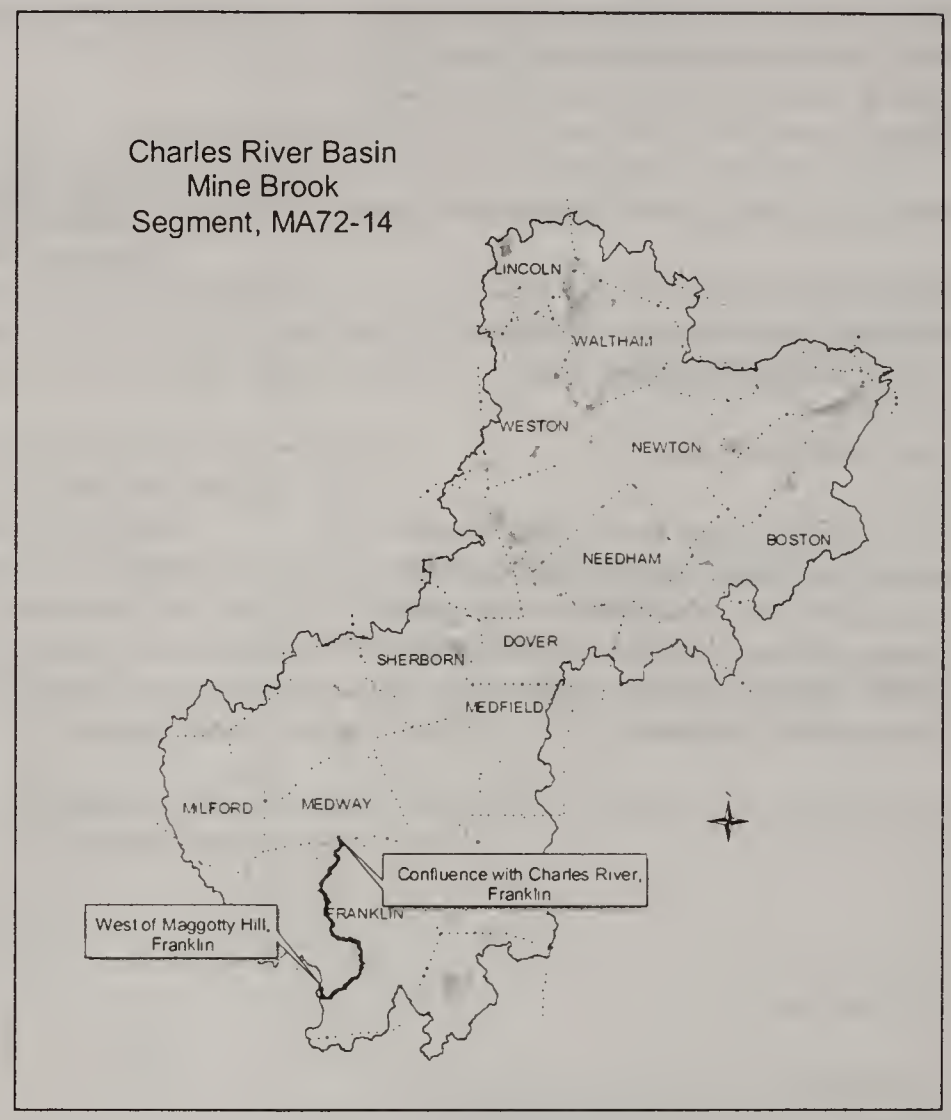
- Field reconnaissance to investigate any current/potential impacts of the water withdrawal on Beaver Brook.

MINE BROOK (SEGMENT MA72-14)

Location: Headwaters in Franklin State Forest, Franklin to confluence with Charles River, Franklin.
Segment Length: 8.7 miles. Classification: Class B, Warm Water Fishery.

SEGMENT DESCRIPTION

Mine Brook originates in the southwestern part of Franklin, in the town's State Forest just south of Hillside Place Road. The stream flows southeast and is joined by Miscoe Brook before heading northeast. Dix Brook flows into Mine Brook downstream of Grove Street. Mine Brook continues to flow north through wetlands, jogs west for a short distance before flowing under Route 140 in Franklin, then meanders through wetlands in a primarily northerly direction to its confluence with the Charles River at the northerly edge of Franklin. The stream falls about 160 feet and has a drainage area of approximately 16 square miles. Land use in the Mine Brook subwatershed is comprised of medium residential with a significant amount of new construction and infrastructure upgrades occurring throughout. The town of Franklin is the presently experiencing one of the largest population growth rates in the state (Bouck 1997).



WITHDRAWALS AND DISCHARGES

WMA:
The primary aquifers supplying Franklin (Mine Brook being one) are presently stressed to the point where future resource planning is essential for the Town to maintain its present growth rate (Bouck 1997). Several public groundwater withdrawals currently exist in the Mine Brook subwatershed, and an additional well is proposed in Franklin State Forest.

1. Public groundwater withdrawals 4101000-01G, 4101000-02G, 4101000-03G, and 4101000-06G in Franklin.

USE ASSESSMENT

Water quality sampling in this tributary system was conducted on 14 November 1996 as part of the IM3 Project (CRWA 1997a). Fecal coliform bacteria did not exceed 50 cfu/100ml at any of the nine stations sampled in this subwatershed. Other water quality variables (dissolved oxygen, temperature, pH, total suspended solids and BOD) all met Class B criteria (Table 3). However, due to the limited dataset, the primary and secondary contact recreational uses are not assessed in Mine Brook.

DEP DWM conducted benthic macroinvertebrate monitoring at one station on Mine Brook (MB02) located just downstream from Route 140 in Franklin (Appendix C). Kick sampling was conducted on 8 July 1997. Habitat quality scored fairly well (136 out of a possible 200). The riparian zone along the left bank is extremely narrow and shows obvious signs of disturbance. There was some evidence of local nonpoint source pollution in the form of road runoff (sediment) from Route 140 and trash. The results of the RBPIII multimetric analysis found the benthic community 70% comparable to the regional reference station at Stony

Brook (ST01). The degree of impairment in the biological condition was slight which is interpreted as indicating partial support of the aquatic life use. Best professional judgement of DWM biologists is that this station is representative of the entire stream in terms of biological integrity although habitat degradation was only observed in close proximity to the sampling reach. The flow was too low upstream of the water withdrawals for benthic macroinvertebrate sampling thereore attempts to bracket the withdrawals (an upstream/downstream evaluation) were unsuccessful (Appendix C).

SUMMARY

Designated Uses		Status
Aquatic Life		The entire 8.7 mile length of this segment partially supports the aquatic life use. This impairment is thought to be the result of slight habitat degradation (embeddedness) in the form of nonpoint source inputs as well as other unknown causes.
Fish Consumption		Not assessed
Primary Contact		Not assessed
Secondary Contact		Not assessed
Aesthetics		The majority of the 8.2 mile length of Mine Brook supports this use, except for 0.5 miles between Grove Street and downstream of Route 140 in Franklin, which is assessed as partial support due to habitat degradation.

RECOMMENDATIONS: Mine Brook (Segment MA 72-14)

- Attempt to evaluate sites in the upper watershed (including Dix and Miscoe brooks) as potential reference stations to bracket currently existing and proposed water withdrawals. Establish baseline conditions downstream of the proposed Franklin State Forest Well.

- Implement recommendations by DEP's Drinking Water Program (Bouck 1997) and other studies (MAPC 1993) that relate to aquifer safe yield. The goal is to preserve the natural flow regime in Mine Brook.

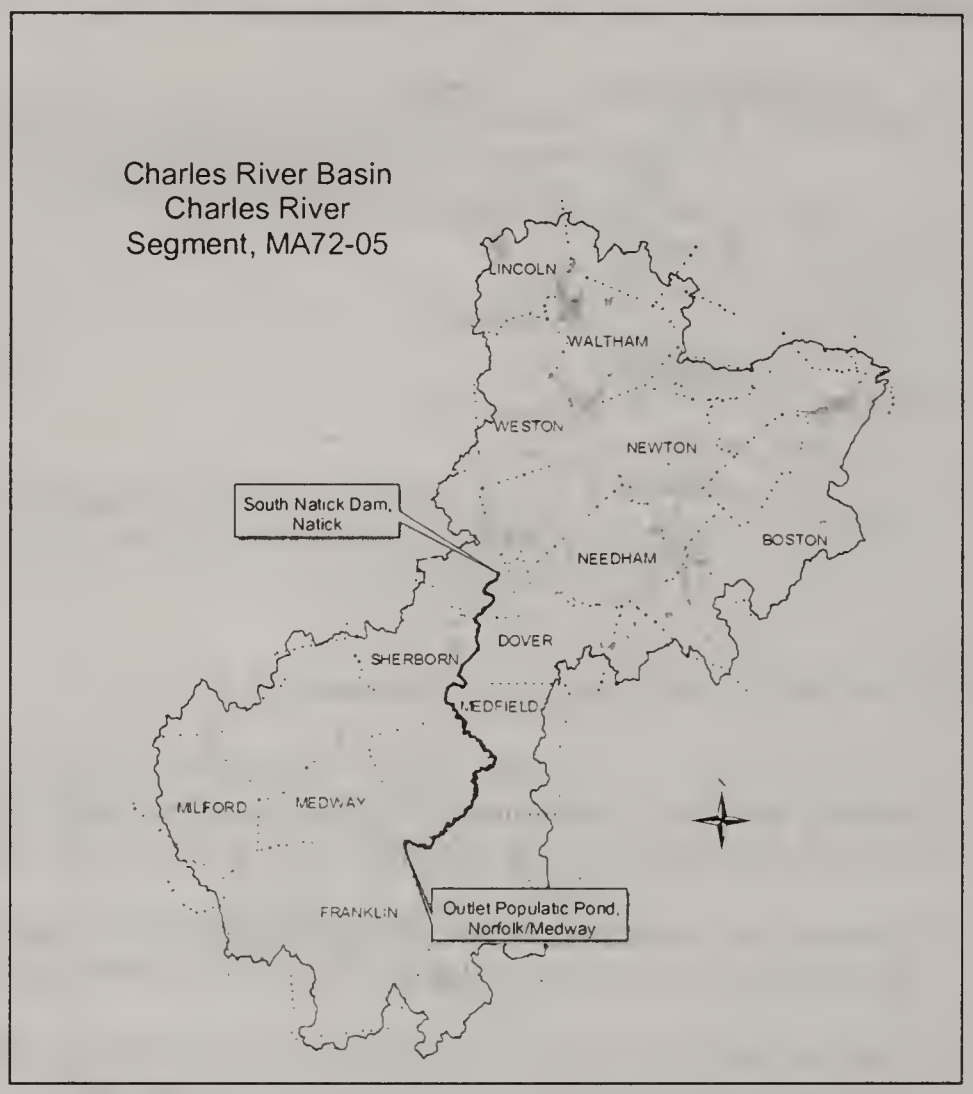
- Implement BMPs to reduce nonpoint source inputs between Grove Street and downstream of Route 140 in Franklin to improve habitat quality conditions (Appendix C).

CHARLES RIVER (SEGMENT MA72-05)

Location: Outlet Populatic Pond, Norfolk/Medway to South Natick Dam, Natick. Segment Length: 17.9 miles.
Classification: Class B, Warm Water Fishery.

SEGMENT DESCRIPTION

The 12 miles between Populatic Pond and Route 27 embraces the largest Charles natural valley storage area, the so-called "marshes" of the Upper Charles. In this and the next two downstream reaches, the river flows at very low gradient – an average of only one-foot fall per mile. As an area of natural flood-water storage and wildlife habitat, this reach acts as a huge "sponge" that substantially modifies flood flows in the river. From Route 27 to the South Natick Dam, the wide marsh area narrows and pine-forested banks rise abruptly from the river shore. These six miles of riverway are largely in estate or trust ownership. This portion of the Charles River Watershed is much less populated and developed than the lower basin.



WITHDRAWALS AND DISCHARGES

WMA:

1. Public groundwater withdrawals 3187000-03G, 3175000-01G, and 3175000-02G in Millis.

NPDES:

1. MA00102598 Charles River Water Pollution Control District (CRWPCD) is permitted to discharge 4.54 MGD of treated municipal effluent directly to the Charles River in Medway. The CRWPCD receives sewered wastewater from Medway and Franklin (facility owners) and Bellingham and Millis (customer towns). Septage is also received at the facility from Dover, Norfolk, Shelburn and Wrentham. The facility is undergoing a two stage upgrade (stage one 5.7MGD and stage two 9.5 MGD) (EPA 1999).
2. MA0100978 Medfield Wastewater Treatment Plant is permitted to discharge 1.52 MGD of treated municipal effluent directly to the Charles River.

USE ASSESSMENT

CDM conducted water quality monitoring for dissolved oxygen, temperature, chlorophyll *a*, total suspended solids, and nutrients in August, September, and October 1996 (CDM 1997). Four Endeco T1184 oxygen-conductivity-temperature loggers were also deployed by Woods Hole Oceanographic Institute (WHOI) in the Charles River (CR3) at Forest Road Medfield/Millis, Charles River (CR4) at West Street, Medfield/Millis (upstream of the Medfield POTW), Charles River (CR5) at Route 27, Sherborn, and Charles River (CR7) upstream of the South Natick Dam, Natick, 12 and 20 inches above the sediment surface (CDM 1997). Although DO's did not drop below 5.0 mg/L, saturation did fall below 60% at the downstream sampling locations where continuous DO measurements were made. Chlorophyll *a* concentrations, a measure of primary productivity, were also elevated ranging between 8.2 and 52.3 μg/L and indicative of enriched conditions (CDM 1997).

On 5-6 August 1997 the EPA Investigations and Analysis Unit conducted a NPDES compliance sampling inspection at CRWPCD in Medway (EPA 1999). The EPA installed a portable ISCO automatic sampler to collect a 24 hour composite of the final discharge. Aliquots were collected every 30 minutes and the composite samples were flow proportioned. The samples were refrigerated until analyzed for CBOD, TSS, ammonia nitrogen, total phosphorus, and total copper. Grab samples were collected from the final dechlorinated effluent for settleable solids, pH, fecal coliform and chlorine residual. Of these ten parameters, only ammonia nitrogen exceeded permit limits (7.9 mg/L). All other parameters were below permit limits with 3.7 mg/L CBOD levels, setteable solids at 0 ml/L and fecal coliform densities of 10 cfu/100ml.

The EPA collected continuous DO, temperature, and pH measurements during the week of 11 August 1997 at upstream of Populatic Pond (station CONT01) using a YSI 6000 sonde (EPA 1998). DO measurements ranged between 5.75 mg/L at 0730 and 13.43 at 1745 hours.

Macroinvertebrate biomonitoring was conducted in this segment on 9 July 1997 by DWM (Appendix C). Sampling was conducted in the Charles River immediately downstream from Dean Street in Millis and downgradient of the Charles River Pollution Control District's regional wastewater treatment facility in Medway. Results of the RBPIII assessment indicate moderate impairment to the benthic community relative to upstream reference conditions (CR03). A total metric score of 14 out of a possible 42 was only 35% comparable to metric scores at CR03. Habitat parameters, however, were highly comparable to the upstream control. Excellent substrates and cover for fish and invertebrates, coupled with a minimally disturbed riparian zone, resulted in a habitat assessment score (160) which was actually better than "least impaired' conditions at CR03. The strong comparability to the reference station in terms of habitat type and quality, coupled with similar streamflow conditions, allowed for a direct comparison of biological condition between upstream and downstream stations. That habitat quality is similar at both sites infers that detected impacts at CR04 can be attributed to water quality factors. The rich filter-feeding macroinvertebrate assemblage found here appears to reflect the effects of considerable organic enrichment, and is indicative of an unbalanced community responding to an overabundance of a food resource (in this case, fine particulate organic material--FPOM). Populatic Pond, which is a eutrophic waterbody (BSC 1988), just upstream of the CR04 sample reach is probably at least partially responsible for the high densities of FPOM at CR04. Lentic systems can be a major source of dissolved and suspended particulate matter to downstream lotic communities—particularly when these systems are subjected to increasingly enriched conditions (Merritt *et al.*. 1984). However, the dominance of filter-feeding organisms in a habitat that should support a diverse benthic community, and almost 100% cover of instream substrates by aquatic vegetation (*Myriophyllum* sp., *Elodea* sp., *Lemna* sp.) and filamentous algae, suggests the effects of nutrient loads and excessive organic enrichment one might associate with a wastewater discharge. In addition, the somewhat low taxa diversity (19), absence of pollution-sensitive EPT taxa, and high biotic index (6.54) indicate potentially low levels of dissolved oxygen—also possibly associated with the CRWPCD discharge.

Macroinvertebrate biomonitoring was again utilized in an attempt to bracket discharge effects from the Medfield POTW (Appendix C). Triplicate artificial substrate samplers were deployed by canoe on 11 July 1997 approximately 1000m upstream from West Street (control site CR05) and approximately 500m downstream from the POTW discharge (study site CR06). Habitat, flow regimes, and depth were similar at both stations and were typical of this portion of the Charles River—a deep, soft bottomed, slow-moving channel meandered through extensive wetlands dominated by purple loosestrife. CR05 received a habitat assessment score of 113 out of 200, while the CR06 habitat evaluation resulted in a score of 131. After a colonization period of about 7 weeks, the artificial substrate multiplate samplers were retrieved and triplicate samplers were processed separately in the lab. The unfortunate loss of two of the three multiplate samplers at the CR05 station precluded the use of statistical hypotheses testing for evaluating discharge impacts to the aquatic community downstream from the Medfield POTW. Instead, the analysis of upstream and downstream macroinvertebrate assemblages was based on the multimetric scoring approach of the RBPIII protocol, in which comparability of metric scores to the reference condition is used to generate an impairment score for the study site. Based on the multimetric comparisons, then, it appears that the CR06 benthic community is not impacted by the Medfield POTW, and is similar to—if not better in terms of biological integrity—the upstream reference community. However, it is important to exercise caution when interpreting the benthos data at CR05 and CR06. It is possible that the disturbance that led to the loss of the two multiplate samplers at CR05 may have affected the remaining sampler as well. Heavy fishing pressure and canoe traffic in this portion of the river may have accounted for disruption of some or all of the multiplate

samplers, which were suspended from fairly conspicuous buoys. Multiplate samplers at the CR05 station may have been particularly susceptible to fouling, vandalism, or other perturbations as they were placed well into the middle of the channel. A final caveat regarding the benthos data at the CR05/CR06 stations is the seemingly dubious "reference" designation of the CR05 station. Virtually all of the organisms found on the CR05 multiplates display extremely high tolerance to organic pollution. Many of these tolerant taxa were found on the CR05 samplers as well. It is possible that the cumulative effects of wastewater treatment facilities further upstream (i.e. CRWPCD, point sources in the Stop River) are being seen at the CR05 and CR06 sites as well. In addition, a large sand and gravel operation just upstream in the vicinity of Route 109 may be another source of anthropogenic impact to the biological integrity of this river segment. Future bioassessments in this portion of the river should include comparisons to a suitable reference station established further upstream in the vicinity of the Charles River headwaters.

Based on the moderately impaired macroinvertebrate assemblage at CR04, the upper 4.4 miles of this segment do not support the aquatic life use. Although the presence of organisms (e.g., Chironomidae) tolerant of organic pollution suggests impairment to the macroinvertebrate communities observed at CR05 and CR06 (although not the result of the Medfield POTW), water quality data indicated somewhat improved conditions. As a result, the lower 13.5 miles of this segment are assessed as partial support. Causes for both assessments are organic enrichment, low levels of dissolved oxygen, and nutrients.

In terms of aesthetic quality, the upper 4.4 miles of this segment do not support the aesthetics use because of the objectionably dense growths of aquatic vegetation observed along this reach (Appendix C). The lower 13.5 miles of this segment are assessed as partial support for the aesthetic use based on turbidity and moderately dense aquatic vegetative growth. Objectionable deposits of solids were also observed in the inlet, which receives the Medfield POTW discharge (Fiorentino 1998).

Fish toxics monitoring was conducted in October 1997 by DWM (Appendix B, Table B7). Elevated levels of mercury in largemouth bass (*Micropterus salmoides*) resulted in an DPH-issued fish consumption advisory for the entire segment. Based on this advisory, the fish consumption use is assessed as non-support for the entire length of the segment (DPH 1998).

The IM3 Project sampled six stations in this segment of the Charles River (CRWA 1998). Fecal coliform bacteria data collected (six stations and 12 sampling events) between May 1996 and September 1997 as part of the baseline monitoring ranged between 10 – 580 cfu/100ml and only one data point exceeded 400 cfu/100ml. Wet weather sampling data ranged between 40 – 12,000 cfu/100ml. To assess the secondary contact recreational use data collected between October 1995 through December 1997 as part of the IM3 Project was used. The data ranged between 5 – 3,100 cfu/100ml fecal coliform bacteria and only two data points (9%) exceeded the maximum of 2,000 cfu/100ml. This data set included 22 separate sampling events at six stations in this reach. Wet weather data ranged between 40 – 12,000 cfu/100ml. Three pH measurements fell outside of the recommended range for swimming (5.2, 9.2 and 9.2 SU), however these points were considered outliers. The high pH measurements at Route 27 in Medfield may warrant further investigation. Based on these bacteria data and the aesthetics use impairment, the primary and secondary contact recreational uses are assessed as non-support in the upper 4.4 miles of the segment and are partially supported in the lower 13.5 miles due to dense mats of aquatic vegetation and stormwater.

Sediment quality monitoring was conducted as part of the IM3 Project. EPA conducted sediment sampling at two stations (CRWA03 and CRWA04) in this segment of the mainstem Charles River in May 1996 (CRWA 1997a). Elevated concentrations of pesticides, heavy metals, and/or PCB were measured in these samples. No acute toxicity, however, was detected where acute sediment toxicity testing was performed.

Both CRWPCD and Medfield POTWs have had problems meeting their whole effluent toxicity testing limits. These effluents have exhibited both acute and chronic toxicity (Dallaire 1998). Effluent toxicity could also contribute to the impairment of water quality in this segment of the Charles River.

SUMMARY

Designated Uses		Status
Aquatic Life		The upper 4.4 miles of this segment do not support the aquatic life use based on the impacts detected in the macroinvertebrate community analysis. The lower 13.5 miles are assessed as partial support. Causes of impairment are organic enrichment, low DO, and nutrients resulting from discharge(s) and other nonpoint sources of pollution.
Fish Consumption		The entire length of the segment does not support this use because DPH has issued a fish consumption advisory due to elevated mercury levels in largemouth bass.
Primary Contact		The upper 4.4 miles of the segment do not support the primary contact use. The lower 13.5 miles are partially supported. Stormwater influence, and possibly point source inputs, impair water quality.
Secondary Contact		The upper 4.4 miles of the segment do not support the secondary contact use. The lower 13.5 miles are partially supported. Stormwater influence, and possibly point source inputs, impair water quality.
Aesthetics		Aesthetics is not supported in the upper 4.4 miles of this segment—a result of objectionably dense growths of aquatic vegetation and turbidity. The lower 13.5 miles are assessed as partial support based on moderate levels of turbidity and vegetative growth.

RECOMMENDATIONS: Charles River (Segment MA72-05)

- The high pH values in the Charles River at Route 27, Medfield warrant further investigation.

- Conduct an instream dissolved oxygen study (diurnal investigation over several days in the summer) to determine whether or not potentially low levels of dissolved oxygen may be contributing to the impairment of the benthic community downstream of the CRWPCD discharge as well as other potential sources in this segment of the Charles River.

- Future bioassessments should be conducted in this portion of the river and include comparisons to a suitable reference station established further upstream in the vicinity of the Charles River headwaters. It is possible that the cumulative effects of wastewater treatment facilities further upstream (i.e., CRWPCD, point sources in the Stop River) are being seen at the CR05 and CR06 sites as well. In addition, a site visit is recommended to the large sand and gravel operation just upstream in the vicinity of Route 109, which may be another source of anthropogenic impact to biological integrity in this river segment.

- Conduct habitat and biological assessments (including flow gaging) in the Charles River at Norfolk Road in Millis and Forest Road in Millis/Medfield, bracketing potential low-flow effects from the proposed Paine Property groundwater wells.

- Conduct additional flow measurements, biomonitoring, and habitat evaluations to assess impacts associated with increased water withdrawals in the vicinity of the Populatic Pond/Charles River aquifers located upgradient of the Populatic Pond. It may be difficult to determine the effects of water withdrawals from other water quality stressors (i.e., CRWPCD, Populatic Pond) in this portion of the segment.

- Continue to monitor both the CRWPCD and Medfield POTW effluents for acute and chronic toxicity. Initiate toxicity identification and reduction evaluations if facilities continue to fail their permit limits.

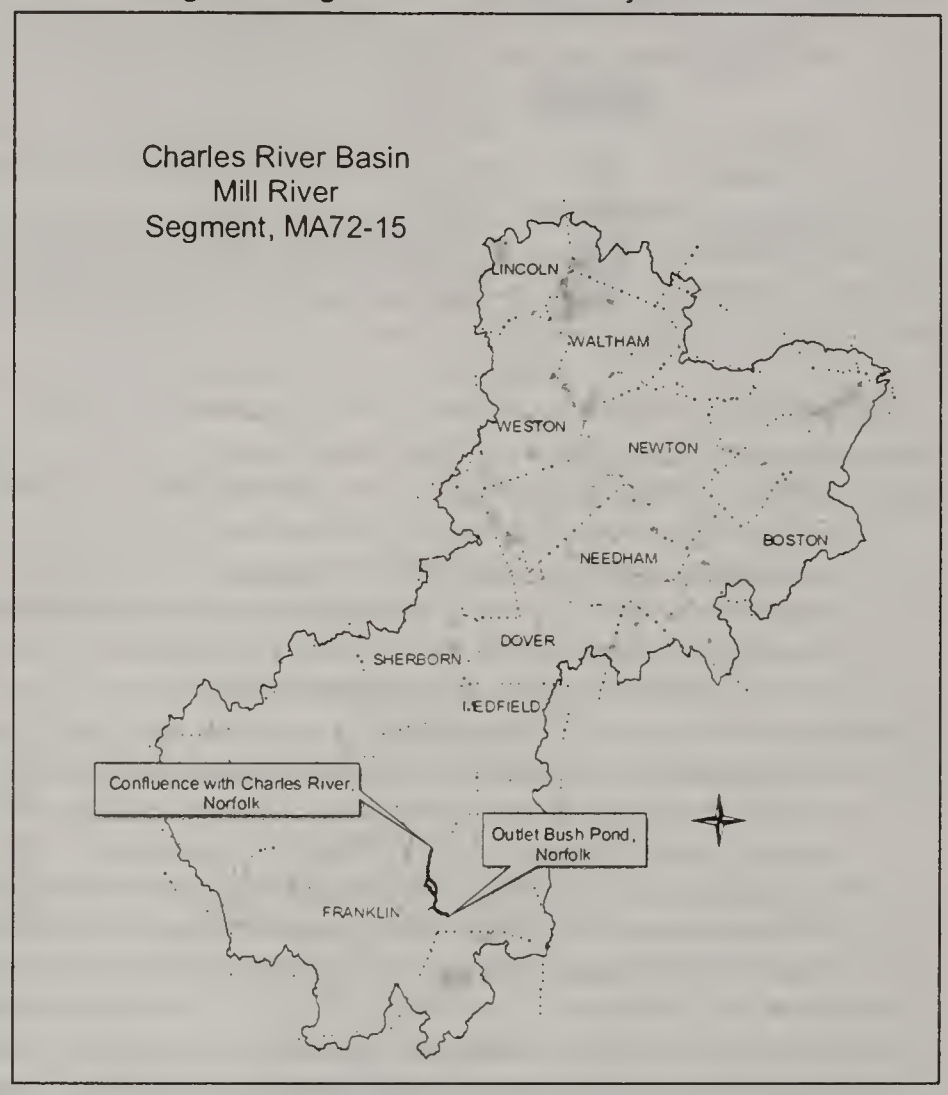
- Continue to monitor fecal coliform bacteria densities and identify and remediate their sources.

MILL RIVER (SEGMENT MA72-15)

Location: Headwaters at outlet of Bush Pond in Norfolk, to confluence with Charles River, Norfolk. Segment Length: 3.4 miles. Classification: Class B High Quality Water.

SEGMENT DESCRIPTION

The Mill River originates in Bush Pond, where it then flows in a northwesterly direction before flowing into City Mills Pond. From there it continues to flow north, receiving discharge from Miller Brook just downstream from Main Street, Norfolk. The river continues to drain an area of extensive wetlands, receiving Cress Brook near the Miller Street crossing. It then meanders in a northerly direction, joining the Charles River just downstream from River Road in Norfolk. In its fall of about 150 feet it drains approximately 16.3 square miles. Lake Pearl and Lake Archer, located in the upper reaches of the tributary, are relatively large bodies of water.



Land use in the Mill River subwatershed is mostly residential. Recent housing construction in several areas will result in the installation of at least one new groundwater well. In several areas, extensive floodplain wetlands border the river for several hundred meters.

WITHDRAWALS AND DISCHARGES

According to the DWS, this is another high priority aquifer in which potential reductions in surface water base flows may be detrimental to resident aquatic biota and habitat (Bouck 1997). Several groundwater wells currently exist along this aquifer, and a new well (Mill River Well) is proposed near the Mill River/Miller Brook confluence, an area experiencing much new residential home construction.

WMA:

1. Public groundwater withdrawals 4101000-04G and 4101000-05G in Franklin
2. Public groundwater withdrawal 3208000-01G in Norfolk

USE ASSESSMENT

CRWA conducted water quality sampling (good spatial coverage throughout the subwatershed) on one date, 17 October 1996 (CRWA 1997a). Although too limited in scope to assess the recreational use status, fecal coliform bacteria counts never exceeded 40cfu/ 100mls. Other water quality parameters sampled--conductivity, BOD, pH, dissolved oxygen, and total suspended solids--met standards (Table 3).

Macroinvertebrate sampling was conducted by DWM approximately 250m downstream from Main Street and City Mills Pond in Norfolk (Appendix C). MR01 served as the upstream control to MR02, and together the two stations provide a "before picture" of biological integrity above and below the proposed Mill River Well. The MR01 reach was an open-canopied, low gradient portion of Mill River that emerges from a hardwood forested before meandering through an extensive wetland area. Although the stream was fairly shallow with good velocity and diverse instream substrates just upstream of MR01, the sampling reach was dominated by soft

substrates and flow regimes characteristic of other low gradient streams in the watershed. While there was no evidence of nonpoint source pollution inputs, considerable amounts of trash (old bottles, scrap metal) were found in the stream. Eight biological metric values were calculated for each triplicate multiplate sampler at MR01. While the amphipod *Gammarus* sp. was well represented on all three samplers, more than half of the triplicate assemblages were dominated by the mayflies *Stenonema* sp. and *Trichorythodes* sp.—generally considered rheophilic forms, as their external gills are dependent on current for respiration (Appendix C).

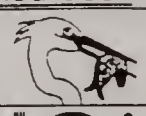
The MR02 triplicate multiplate samplers were deployed approximately 15m downstream from Miller Street in Norfolk and roughly 1200m downstream from the proposed Mill River Well site. This portion of the stream slowly meanders through extensive wetlands before joining with the Charles River at the Norfolk-Millis border. Overall habitat at MR02 was comparable to the upstream control. The potential for NPS inputs (primarily road runoff) is highest at this point and just upstream at the Miller Street stream crossing. Metric values were again calculated for each triplicate sampler at MR02. All three samplers supported communities dissimilar to those found on the MR01 samplers. The numerical dominance of the amphipod *Hyalella azteca* and the isopod *Caecidotea communis* no doubt contributes to the high biotic index values for the MR02 triplicate assemblages, which are significantly different than those for the MR01 triplicate assemblages. Other metric values that were significantly different than those for the MR01 assemblages are EPT/Chironomidae, and community similarity. The three diversity metrics, however, were not significantly different than upstream values, nor was the percent dominant taxon metric value. The scraper/filterer metric value was not significantly different from the MR02 mean value when using the Student's t-test. However, the Mann-Whitney Test—which is a less robust, yet, more conservative analysis of the benthos data—did show a significant difference between these metrics (Appendix C).

Significant differences in community structure and metric values between the MR02 multiplate assemblages and those at MR01 were somewhat unexpected, and reasons for these discrepancies are not completely clear (Appendix C). The apparent displacement of pollution-sensitive rheophilic macroinvertebrates by numerous slow-water forms, relative to the upstream station, may be a function of flow regimes. Current velocities measured at MR02 averaged 0.22 feet per second (fps), while velocity at the MR01 station was 0.72 fps. In addition, instream and riparian habitat—which was considered similar at both multiplate sites, was markedly different just upstream of each station. The forested stream system just upstream of MR01 may offer different food resources to the immediate downstream aquatic community than at MR02--which is surrounded by a vast expanse of open-canopied wetland and may support a somewhat different trophic guild (Appendix C).

Despite significant differences in some of the metric values between the MR02 and MR01 multiplate assemblages, MR02 was considered only slightly impaired (Appendix C). The aquatic life use for the entire segment is assessed as support.

Based on instream and riparian habitat quality, water column clarity, and minimal aquatic vegetative cover throughout the segment, the aesthetic use is assessed as support for the entire 3.4 miles of this stream.

SUMMARY

Designated Uses		Status
Aquatic Life		The entire 3.4 mile length of this segment supports this use based on a benthic macroinvertebrate community that reflects little to no impairment.
Fish Consumption		Not assessed
Primary Contact		Not assessed
Secondary Contact		Not assessed
Aesthetics		The entire 3.4 mile length of this segment supports this use.

RECOMMENDATIONS: Mill River (Segment MA72-15)

- Continue to monitor biological integrity upstream and downstream of the Mill River groundwater well, using both baseline (1997) macroinvertebrate data and newly collected data. Future monitoring activities should include flow measurements at upstream and downstream biomonitoring stations.

- To preserve the high aesthetic quality in this river, reduce nonpoint source inputs (trash), specifically dumping activities adjacent to the stream (downstream of Main Street, Norfolk).

- Conduct a site visit of the new housing subdivision located between the MR01 and MR02 stations and adjacent to the Mill River system, to identify any potential NPS inputs between the two sampling reaches and may be contributing to the slight impairment of the MR02 benthic community.

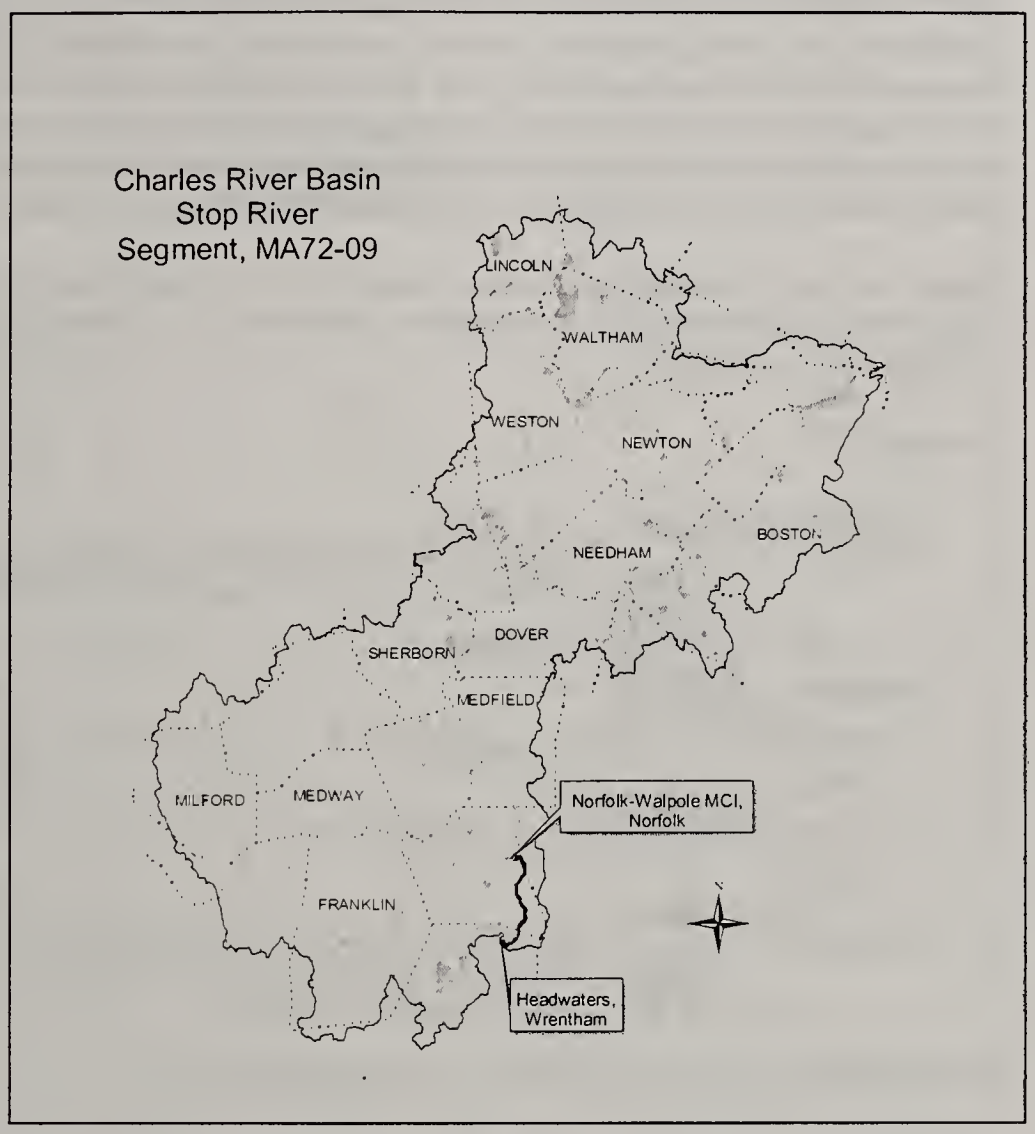
- Conduct future water quality monitoring, for fecal coliform bacteria and dissolved oxygen near the confluence with the Charles River at River Road, Norfolk.

STOP RIVER (SEGMENT MA72-09)

Location: Headwaters, Wrentham to Norfolk-Walpole MCI discharge, Norfolk. Segment Length: 4.7 miles.
Classification: Class B Warm Water Fishery.

SEGMENT DESCRIPTION

This segment of the Stop River originates in the headwaters near Dedham Street, Wrentham. The river flows in a northeasterly direction through a series of small impoundments before reaching an area of extensive wetlands, after which it soon receives the effluent discharges of both Southwood Community Hospital and the Wrentham State School. The river continues to flow in a generally northerly direction, receiving the drainage from Mann Pond in Norfolk before entering Highland Lake just downstream from Main Street, Norfolk. From the outlet of Highland Lake near Campbell Road in Norfolk, the segment continues north for about 0.5 miles before terminating at the Norfolk-Walpole MCI facility's discharge.



Much of the segment runs through areas of open space, light residential use, commercial use, industrial, and in some cases extensive wetlands. A sand and gravel operation is situated adjacent to the river in the vicinity of Pine Street, Norfolk.

WITHDRAWALS AND DISCHARGES

WMA:

1. Groundwater withdrawals (3208002-01G and 3208002-02G are Southwood Community Hospital wells), 3208001-01G, 3208001-03G, 3208001-04G, 4350001-01G, and 3208000-02G in Norfolk

NPDES:

1. MA0102113 Wrentham State School's WWTP, Wrentham
2. MA0102288 Southwood Community Hospital's treatment facility, Norfolk

USE ASSESSMENT

CRWA conducted water quality sampling with on one date, 7 November 1996 (CRWA 1997a). Although too limited in scope (i.e., only two stations) to assess the recreational use status, fecal coliform bacteria counts never exceeded 20 cfu/ 100mls. Other water quality parameters sampled--conductivity, BOD, pH, dissolved oxygen, and total suspended solids met standards (Table 3).

Benthic macroinvertebrate biomonitoring was conducted at two stations in this segment to bracket the combined effects of the State School and Hospital discharges (Appendix C). An upstream reference station, SR01, was established at Pine Street in Norfolk. Based on the well-balanced, diverse, and minimally

impaired benthic community sampled at SR01, the upper 0.9 miles of the segment (from the headwaters near Dedham Street, Wrentham to Dedham Street, Norfolk) are assessed as support for aquatic life use.

The downstream biomonitoring station was at Campbell Street, just downstream from Highland Lake (Appendix C). SR02 received a habitat assessment score of 177 out of 200--one of the highest scores in the watershed. While the diverse and undisturbed instream habitat should have supported an equally diverse aquatic community, the SR02 benthos received a total metric score of 16. The low percent comparability (38%) to upstream reference station metrics resulted in a moderate impairment designation. Based on the moderately to severely impaired benthic community (as reflected in the overall low taxa diversity, high community dominance by a taxon, and an assemblage very dissimilar to the reference), the lower 3.8 miles of this segment are assessed as non-support for the aquatic life use designation. Causes of impairment are organic enrichment (possibly originating from the combined effects of the Wrentham State School and Southwood Community Hospital point source discharges)/low dissolved oxygen and unknown.

Based on good instream and riparian habitat quality, good water column clarity, and minimal aquatic vegetative cover throughout the segment (Appendix C), the aesthetic use assessment supports for the entire 4.7 miles of the segment.

SUMMARY

Designated Uses		Status
Aquatic Life		The upper 0.9 mile of the segment supports this use. The lower 3.8 miles do not support this use. Causes of impairment are organic enrichment/low DO, and unknown.
Fish Consumption		Not assessed
Primary Contact		Not assessed
Secondary Contact		Not assessed
Aesthetics		Based on good instream and riparian habitat quality, good water column clarity, and minimal aquatic vegetative cover throughout the segment, the aesthetic use assessment supports for the entire 4.7 miles of the segment.

RECOMMENDATIONS: Stop River (Segment MA72-09)

- Conduct site visits at both NPDES wastewater facilities. Review existing NPDES permit limits for Southwood Community Hospital and Wrentham State School, note compliance or violations, and make recommended modifications where necessary.

- Conduct macroinvertebrate biomonitoring to bracket each of the NPDES discharges; the Southwood Community Hospital and Wrentham State School to determine if either discharge is impacting the Stop River.

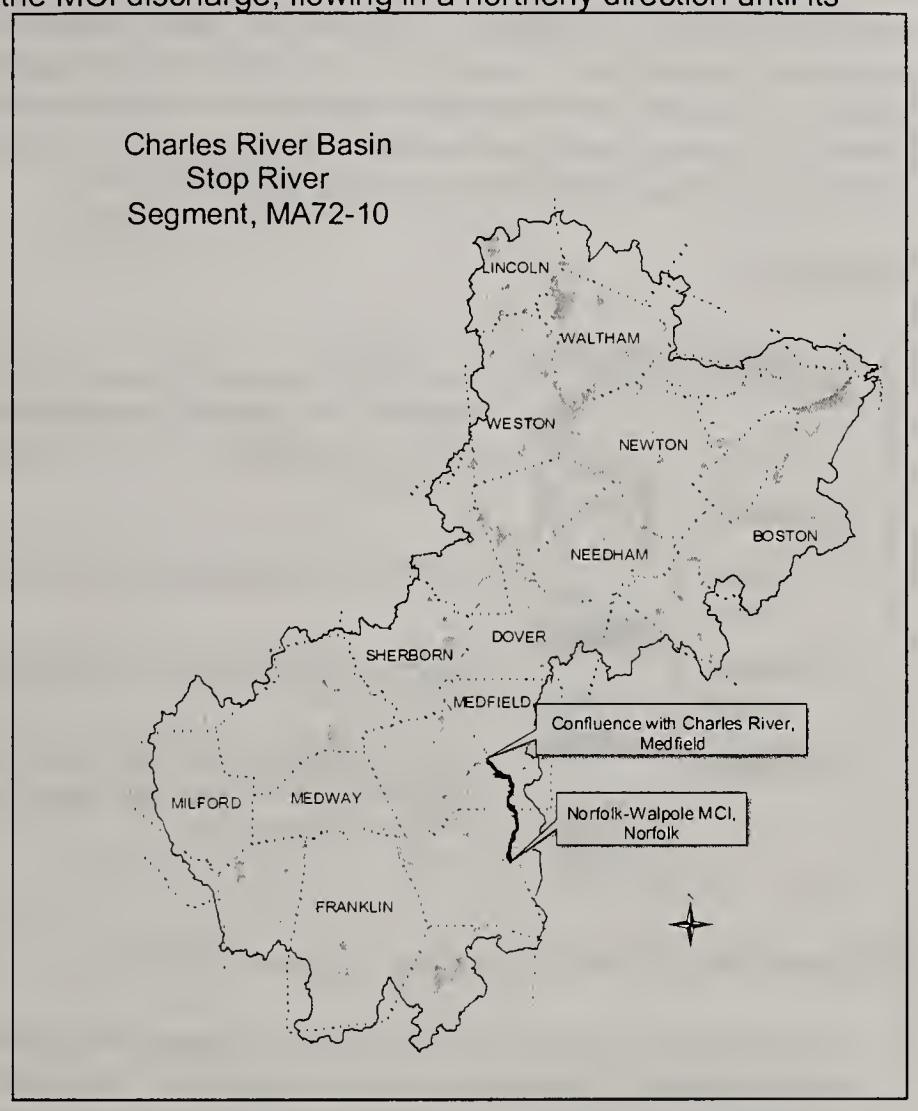
- Monitor dissolved oxygen levels (including predawn readings) and fecal coliform bacteria downstream from both the Southwood Community Hospital and Wrentham State School discharges.

STOP RIVER (SEGMENT MA72-10)

Location: Norfolk-Walpole MCI, Norfolk to confluence with Charles River, Medfield. Segment Length: 4.1 miles. Classification: Class B, Warm Water Fishery.

SEGMENT DESCRIPTION

This segment of the Stop River originates at the MCI discharge, flowing in a northerly direction until its confluence with Horse brook in Medfield. From there it heads in a northwesterly direction, through extensive wetlands before joining the Charles River just downstream from Causeway Street and Sewell Brook, Medfield.



Much of the segment runs through areas of open space, light residential, and in many cases extensive wetlands. Some evidence of new home construction was observed throughout the subbasin, specifically along Noon Hill Street in Medfield.

WITHDRAWALS AND DISCHARGES

NPDES:

1. Norfolk MCI wastewater treatment facility (MA0102253). Compounding the effects of point source inputs may be a reduction in stream flow resulting from several upstream water withdrawals (Norfolk MCI Well #1, #2, #3, #4)—all included in the withdrawals list in the preceding segment.

USE ASSESSMENT

CRWA conducted monthly water quality sampling (temperature, conductivity, pH, BOD, total suspended solids and fecal coliform bacteria) in the Stop River at Noon Hill Street, Medfield (269T) between May 1996 and December 1997 (CRWA 1998). Fecal coliform bacteria data collected during the 16 baseline sampling events ranged between 10 – 280 cfu/100ml. Wet weather sampling data was collected during ten separate events between September 1996 and October 1997. These data ranged between 70 – 3,100 cfu/100ml. During the primary contact recreational use season (15 April to 30 September) only one data point (10%) exceeded the maximum of 2,000 cfu/100ml. Therefore the primary contact recreational use is assessed as support. The secondary contact recreational use is also assessed as fully supporting in this segment.

Macroinvertebrate biomonitoring downstream from the MCI discharge was conducted at Noon Hill Street in Norfolk (Appendix C). The benthos data suggested an imbalanced macroinvertebrate community, with the filter-feeding Hydropsychidae comprising the majority of the assemblage sampled. Based on the moderate impairment evaluation for the SR03 macroinvertebrate community relative to both the regional reference station ST01 and the upstream reference station SR01, the aquatic life use is assessed as non-support for the entire 4.1 miles of this segment. Organic enrichment, resulting from the combined effects of all upstream point source inputs to the Stop River, probably accounts for most of the water quality degradation reflected in the resident aquatic community. Reduced dissolved oxygen levels may sporadically exist throughout the segment (either a function of the low-gradient wetland stream system and/or organic enrichment), however, current data may be unreliable. DO measurements (CDM 1997) found post-dawn DO levels as low as 3.8 near the confluence with the Charles River; however, these readings differed greatly from those taken by CRWA at the same station a few months later (CRWA 1998), when DO levels met standards (Table 3).

The Norfolk-Walpole MCI facility has conducted whole effluent acute and chronic toxicity testing on a quarterly basis since April 1991 (Dallaire 1998). Fourteen test events have occurred since March 1994 (in the last five years). The effluent has consistently met the acute toxicity limit. Sporadic chronic toxicity to both *Ceriodaphnia dubia* and *Pimpephales promelas*, however, has been detected (chronic no observed effect level or CNOEC $\leq$ 30%) which is interpreted as a threat to the receiving stream.

Based on instream and riparian habitat quality, water column clarity, and minimal aquatic vegetative cover throughout the segment (Appendix C), the aesthetic use assessment supports for the entire 4.1 miles of the segment. The sediment deposition observed in the SR03 sample, while potentially impacting the resident biota of the sample reach, appeared to be localized only (probably a result of road runoff from Noon Hill Street) and not representative of the entire segment.

SUMMARY

Designated Uses		Status
Aquatic Life		Based on the moderately impaired benthic community, the entire 4.1 miles of this segment are assessed as non-support for the aquatic life use designation. Causes of impairment are organic enrichment and possibly low dissolved oxygen, and unknown.
Fish Consumption		Not assessed
Primary Contact		The entire 4.1 mile length supports this use
Secondary Contact		The entire 4.1 mile length supports this use
Aesthetics		Based on instream and riparian habitat quality, water column clarity, and minimal aquatic vegetative cover throughout the segment, the aesthetic use assessment supports for the entire 4.1 miles of the segment.

RECOMMENDATIONS: Stop River (Segment MA72-10)

- Review NPDES permit limits for Norfolk-Walpole MCI, note compliance or violations, and make recommended modifications where necessary. Continue to monitor whole effluent toxicity (particularly chronic) and initiate toxicity identification and reduction evaluations if chronic toxicity continues to be problematic.

- Continue to conduct macroinvertebrate biomonitoring downstream from MCI discharge to document changes resulting from improvements at the Norfolk-Walpole MCI treatment facility.

- Monitor dissolved oxygen levels (including predawn readings) near the confluence with the Charles River to establish baseline conditions to increase spatial coverage and allow for a more definitive assessment of the aquatic life use.

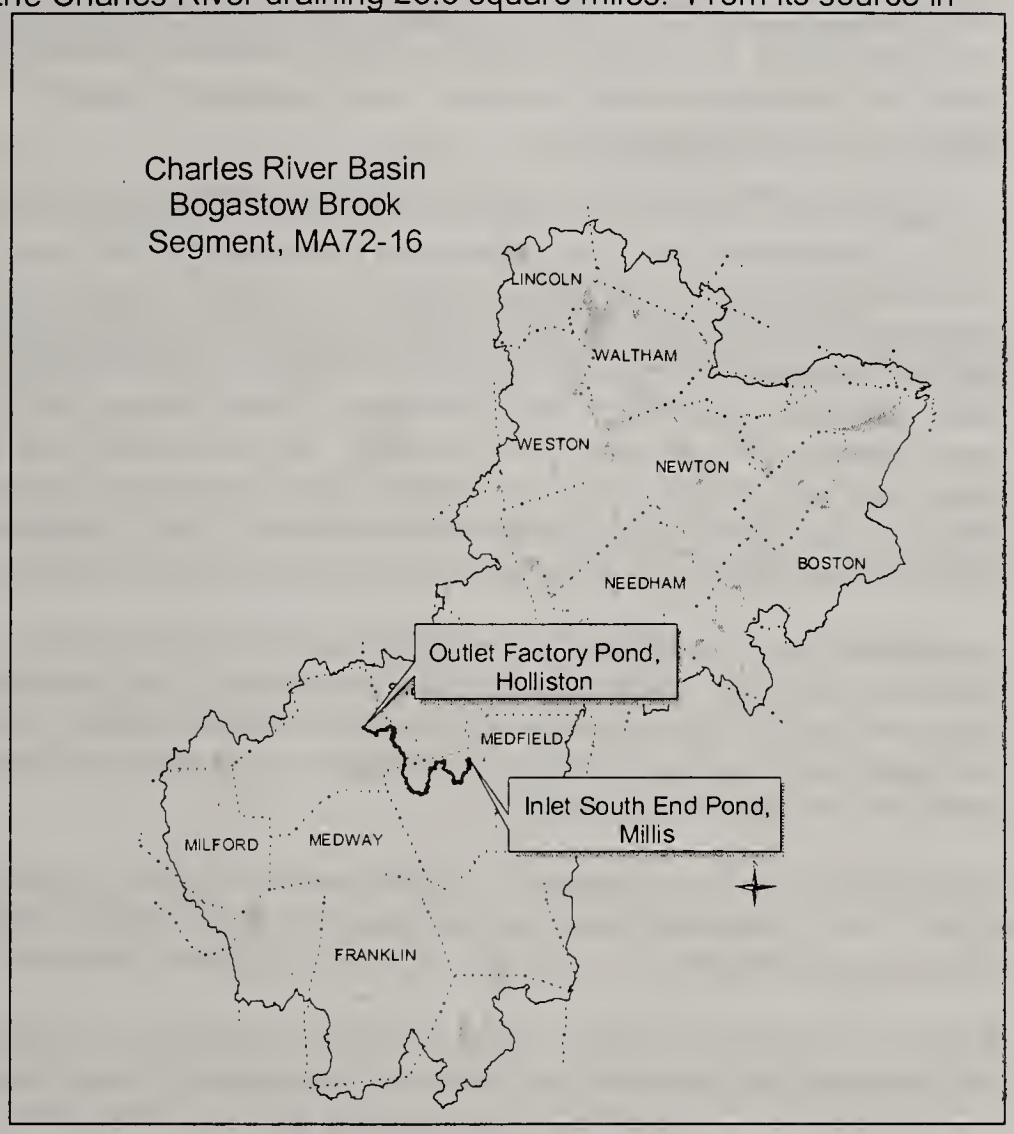
- Identify major NPS inputs to this segment emphasizing road crossings where runoff contributes to instream sediment deposition. Implements BMPs (e.g., reduce sediment loading) where appropriate.

BOGASTOW BROOK (MA72-16)

Location: Outlet of Factory Pond, Holliston to inlet South End Pond, Millis. Segment Length: 10.14 miles.
Classification: Class B High Quality Water.

SEGMENT DESCRIPTION

This stream is the largest tributary of the Charles River draining 25.5 square miles. From its source in Holliston, the stream flows 9 miles generally to the southeast, turns northerly at Great Black Swamp, and travels northeasterly for about 3 miles to its confluence with the mainstem Charles River in the town of Millis. The tributary basin contains numerous large ponds, notably Lake Winthrop. Extensive wetlands along the downstream portion provide a large natural storage area. The Bogastow Brook Watershed includes five small tributaries: Dirty Meadow Brook, Winthrop Canal, Jar Brook, Dopping Brook, and Great Black Swamp. The drainage area is comprised primarily of open space and low residential land use.



WITHDRAWALS AND DISCHARGES

WMA:
A community public water supply currently exists along this stream just downstream of the East Holliston section of town, between Fiske Street and Central Street—an area with several new subdivisions developed over the last twenty years. Suspected septic system failure in this area may compound low flow effects with water quality impacts.

1. Public groundwater withdrawal 2136000-05G in Holliston
2. Public groundwater withdrawal 3187000-04G in Millis

USE ASSESSMENT

The IM3 Project sampled six stations along Bogastow Brook for fecal coliform bacteria on one date 14 October 1997 (CRWA 1998). DWM sampled five of the same stations as well as one other location on two dates, 1 July and 19 August 1997 (Appendix B, Table B5). The July fecal coliform data ranged between 100 – 180 cfu/100ml representing dry weather conditions while the August data set, 80 – 600 cfu/100ml, represented wet weather conditions. Limited fecal coliform bacteria sampling was also conducted in select tributaries (Winthrop Canal, Jar Brook, Dopping Brook, Dirty Meadow Brook and three unnamed streams) by both DWM and CRWA (Appendix B, Table B5 and CRWA 1998). One elevated bacteria count (800 cfu/100ml) was found only on one date (July) in Dopping Brook. Based on these data the primary and secondary contact recreational uses are assessed as support. Although negative results from optical brightener screening at two stations in Bogastow Brook (Appendix B, Table B6) support this assessment, the optical brightener samplers had only been deployed for one day and previous attempts at optical brightener screening were inconclusive (silt on sampling pads).

An upstream-downstream macroinvertebrate sampling approach was taken to bracket the potential effects of reduced flow in this portion of the subwatershed (Appendix C). Flow measurements, taken on 8 July 1997, found this segment of Bogastow Brook to discharge at a rate of 2.14 cfs, which was higher than the discharge upstream from the groundwater withdrawal. The benthic macroinvertebrate sampling reach BB04 began approximately 200m downstream from Fiske Street in Holliston; however, rather than sampling throughout the 100m reach, artificial substrate samplers—arranged as triplicates (BB04-1; BB04-2; BB04-3)--were placed approximately midreach at a depth of about 0.75m. The BB04A sampling reach began approximately 300m upstream from Central Street in Holliston, and was located about 700m downstream from the groundwater well. The sampling reach was very similar to the BB04 station—slow moving and meandering through an extensive riparian zone dominated by wetland vegetation. The aquatic community at BB04A was determined to be nonimpaired.

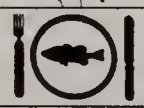
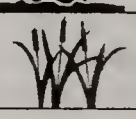
It appears, then, that the groundwater well adjacent to Bogastow Brook is not adversely affecting aquatic life, at least in the stream segment immediately downstream of the water withdrawal. Minimal or no impairment to the BB04A benthic community, instream and riparian habitats considered better than the upstream control station, and a discharge rate higher than that at the control station corroborate this conclusion. The macroinvertebrate communities found at the BB04 and BB04A stations may, in fact, be more reflective of water quality than quantity. The highest fecal coliform bacteria density in Bogastow Brook (600 cfu/100 mls) was at station BB04 (Appendix B, Table B5). The fecal coliform bacteria densities at the Bogastow Brook station upstream of BB04 were low. Since these two stations bracket the confluence of Dopping Brook, which had the highest fecal coliform bacteria density in the Bogastow Brook subwatershed (800 cfu/100mls), it appears that Dopping Brook may be contributing to the elevated bacteria levels in Bogastow Brook.

Qualitative macroinvertebrate biomonitoring was also conducted in two Bogastow Brook tributaries—Dopping Brook and Jar Brook. While the sampling conducted did not yield definitive assessment results, the benthos data collected did help in discerning the impacts of water quality, water quantity, and habitat quality issues in the Bogastow Brook subwatershed. Results of this sampling are provided in the Charles River Biomonitoring technical memorandum (Appendix C).

Dissolved oxygen was measured by CDM just downstream of South End Pond at several times on six dates (CDM 1997). No measurements were below 5.7 mg/L. IM3 DO data from Bogastow Brook collected near noon ranged between 6.2 – 7.3 mg/L. Lower DO's were measured in some of the tributaries (CWRA 1998).

Based on the seemingly healthy benthic macroinvertebrate assemblage sampled in this segment, coupled with generally high dissolved oxygen levels, the aquatic life use was assessed as support for the entire 9.3 miles of the river. The aesthetics use was also assessed as support based on good instream and riparian habitat quality parameters, good water column clarity, and minimal nuisance aquatic vegetative growth.

SUMMARY

Designated Uses		Status
Aquatic Life		The entire 9.3 miles of this segment support this use.
Fish Consumption		Not assessed
Primary Contact		The entire 9.3 miles of this segment support this use.
Secondary Contact		The entire 9.3 miles of this segment support this use.
Aesthetics		The entire 9.3 miles of this segment support this use.

RECOMMENDATIONS: Bogastow Brook (MA72-16)

- Identify major NPS inputs to this segment emphasizing road crossings where runoff contributes to instream sediment deposition. Implements BMPs (e.g., reduce sediment loading) where appropriate.

- Monitor dissolved oxygen levels (including predawn readings) and water quality (fecal coliform bacteria) at multiple stations (including upstream from South End Pond and Bogastow Pond) to establish baseline conditions (increasing spatial coverage) to allow for a more difinitive assessment of the primary and secondary recreational use statuses.

- Investigate possible sources of elevated dry weather fecal coliform levels in Dopping Brook, particularly in the vicinity of Whitney Street. Conduct additional bacteria sampling at Whitney Street and further upstream at Brook Street.

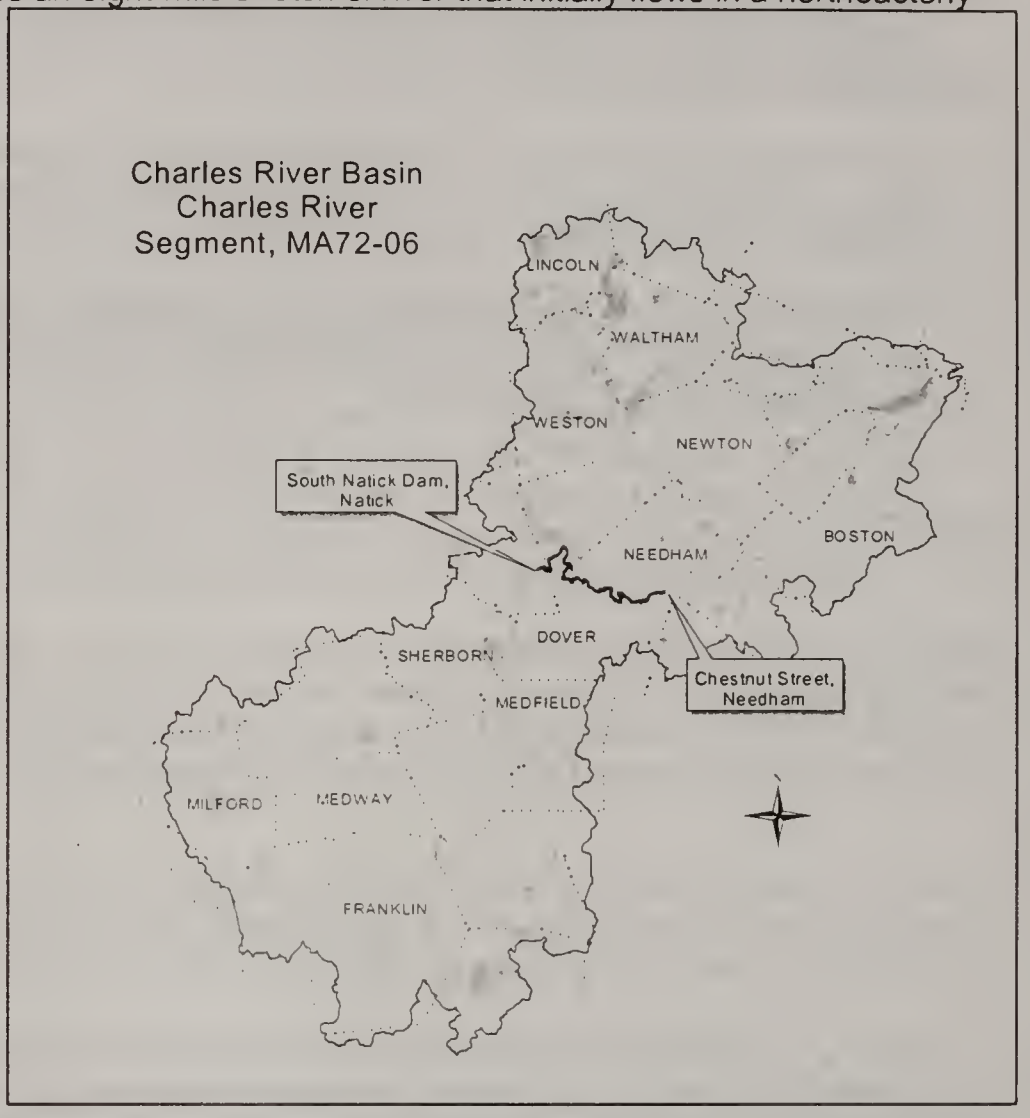
- Continue to monitor (upstream/downstream) the potential impact from existing and proposed groundwater withdrawals in Dopping Brook via biological monitoring (benthic macroinvertebrate sampling and analysis and habitat evaluations).

CHARLES RIVER (SEGMENT MA72-06)

Location: South Natick Dam, Natick to Chestnut St., Needham. Segment Length: 8.0 miles.
Classification: Class B Warm Water Fishery.

SEGMENT DESCRIPTION

This segment of the Charles River includes an eight-mile stretch of river that initially flows in a northeasterly direction until it receives the combined discharges of Waban and Fuller brooks in Wellesley. After this the river flows in a generally southeasterly direction until it reaches Chestnut Street in Needham. Land use is fairly uniform and includes light residential, open space and some agriculture.



WITHDRAWALS AND DISCHARGES

WMA:

1. Two public groundwater supplies near Elm Bank Reservation: 3198000-11G and 3198000-12G in Wellesley
2. Three public groundwater supplies near Charles River Road: 3199000-02G, 3199000-04G and 3199000-01G in Needham
3. Public groundwater withdrawal 3078005-01G and 3078006-02G in Dover

USE ASSESSMENT

Water quality monitoring in this reach of the Charles River included one DWM sampling station located in the MDC (Metropolitan District Commission) Elm Bank Reservation (CR02), IM3 and CDM stations were located at Charles River Road in Dover and at the Cochrane Dam in Dover at the USGS gage. DWM sampling included in-situ measurements using the Hydrolab™ multiprobe analyzer as well as nutrient and chemistry samples between June 1997 and April 1998 (Appendix B, Tables B3 and B4, respectively). Fecal coliform samples were collected on seven dates between July 1997 and April 1998 (Appendix B, Table B5). The IM3 Project collected fecal coliform samples in October and November 1995 (Lancaster *et al.* 1995), and monthly between May 1996 and December 1997 (CRWA 1998). Some water quality variables (temperature, pH, total suspended solids) were also measured in monthly between August 1996 and December 1997 at both locations. CDM conducted water quality monitoring for dissolved oxygen, temperature, chlorophyll *a*, total suspended solids, and nutrients in August, September, and October 1996 (CDM 1997). Two Endeco T1184 oxygen-conductivity-temperature logger was also deployed by Woods Hole Oceanographic Institute (WHOI) in the Charles River upstream of the Cochrane Dam in Dover 12 and 20 inches above the sediment surface (CDM 1997). The EPA, as part of their Charles River Water Quality Study (EPA 1998), recorded continuous DO, temperature, and pH readings approximately 50 feet above Cochrane Dam from 12 August 1997 to 15 August 1997.

Measurements of dissolved oxygen in the Charles River taken during the DWM surveys ranged between 6.6 and 13.2 mg/L in this segment (Appendix B, Table B3). None of the measurements were pre-dawn and therefore do not represent worse-case conditions. The WHOI datalogger profiles, however, did record dissolved oxygen levels below 5.0 mg/L and percent saturation was also below 60 in mid-September 1996 (CDM 1997). EPA recorded multiple DO readings below 5.0 mg/L during two days of their sampling period (EPA 1998). Chlorophyll *a* concentrations ranged from 1.2 to 50.3 µg/L (highest concentrations in August

1996) and are indicative of enriched conditions (CDM 1997). Elevated nutrients levels, particularly phosphorus (as high as 0.21 mg/L), were also measured. Other water quality variables (pH, conductivity, and temperature) were within Class B criteria. Based on these data the aquatic life use is assessed as partial support for the eight-mile length of this segment.

Aesthetics is also assessed as partial support based on the presence of some aquatic nuisance vegetation and turbidity. Some habitat alterations in the form of riparian disturbances are also occurring in this segment, particularly in the vicinity of Elm Bank (Fiorentino 1998).

In August 1994, fish were collected from this segment of the Charles River at the request of a concerned citizen. DPH reviewed the results of the fish toxics monitoring data and subsequently issued a consumption advisory because of elevated levels of PCB in common carp (DPH 1998). The fish consumption use is therefore assessed as non-support for this segment.

Fecal coliform bacteria ranged between <10 – 800 cfu/100ml and only four data points exceeded 400 cfu/100ml (Lancaster *et al.* 1995 and CRWA 1998). Wet weather sampling data ranged between 30 – 15,500 cfu/100ml. Based on these data, the primary contact recreational use is assessed as partial support primarily due to the influence of stormwater.

To assess the secondary contact recreational use, IM3 Project data collected between October 1995 through December 1997 were used (Lancaster *et al.* 1995 and CRWA 1998). None of the dry weather or baseline samples exceeded 2,000 cfu/100ml (Assessment Methodology), however the wet weather data did exceed the 4,000 cfu/100ml criterion which results in partial support for secondary contact recreation.

SUMMARY

Designated Uses		Status
Aquatic Life		Partial support for the entire length of this segment. Causes of impairment include organic enrichment/low dissolved oxygen, nutrients and unknown.
Fish Consumption		The entire length of this segment does not support the fish consumption use because of a DPH fish consumption advisory based on elevated levels of PCB in carp.
Primary Contact		The entire 8.0 mile length partially supports the primary contact use. Stormwater influence impairs water quality.
Secondary Contact		The entire 8.0 mile length partially supports the primary contact use. Stormwater influence impairs water quality.
Aesthetics		Aesthetics is partially supported in the entire length of this segment based on the presence of nuisance aquatic vegetation and turbidity.

RECOMMENDATIONS: Charles River (Segment MA72-06)

- Intensive bacteria sampling is recommended in the vicinity of the South Natick-Wellesley border to discern the effects of stormwater inputs from the village of South Natick and agricultural inputs originating from farms adjacent to Route 16 and the river—both of which are suspected sources of pathogens. Bracketing the mouth of Waban Brook/Fuller Brook is also recommended, as these tributaries may contribute elevated levels of fecal coliform bacteria as well.

- Identify and evaluate riparian habitat alterations in Elm Bank, where infrastructure upgrades warrant BMP improvements and/or implementation.

- Conduct continuous monitoring of dissolved oxygen levels throughout the segment, especially during periods of low flow to establish "worse case" baseline conditions.

- Habitat and biological assessments are recommended in the mainstem Charles River between Elm Bank and the confluence with Trout Brook to investigate potential impacts of the Elm Bank and Needham groundwater withdrawals on instream biological integrity.

WABAN BROOK (SEGMENT MA72-17)

Location: Outlet Waban Lake, Wellesley to confluence with the Charles River, Wellesley. Segment Length: 0.6 miles. Classification: Class B High Quality Water.

SEGMENT DESCRIPTION

The Waban Brook Watershed drains heavily residential portions of Weston and Wellesley in addition to a golf course prior to its confluence with the Charles River. The upper watershed area contains several impoundments including Morses Pond and Lake Waban. Two small brooks, Boulder and Bogle are tributaries to Morses Pond while Fuller Brook merges with Waban Brook just upstream of its confluence with the Charles River.

WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0035840 The Rivers School
2. MA00036765 Merit Oil Corporation
3. MA0034568 Mobil Oil Company Natick

USE ASSESSMENT

The calculated 7Q10 discharge for this brook upstream from State Highway 16, was 0.13 cfs (Ries 1999). DEP DWM collected stream discharge measurements in Waban Brook between August 1997 and April 1998. These discharge measurements ranged from below the 7Q10 (too low to measure) to almost 30 times higher than the 7Q10 at 37.9 cfs (Appendix B, Table B2).

Water quality monitoring was conducted at two locations in this segment. DWM and IM3 sampled Waban Brook off of a dirt road off of Service Road just upstream of its confluence with Fuller Brook. CDM sampled Waban Brook downstream of its confluence with Fuller Brook approximately 250 feet upstream of the mouth.

Dissolved oxygen measurements in Waban Brook ranged between 6.1 and 13.3 mg/L (both DWM and IM3 data) collected between August 1997 and April 1998 (Appendix B, Table 3B and CRWA 1998). None of these DO measurements were collected before dawn, however, and do not represent worse-case conditions. CDM measured dissolved oxygen between August and October 1996 (the earliest measurement at 0800) as well as chlorophyll *a* that was low (between 1.1 and 4.3 µg/L) (CDM 1997). Other water quality variables (pH and temperature) were good and total suspended solids were low (all <2.5 mg/L). Nutrient data collected by CDM did indicate somewhat high levels of phosphorus in August and October 1996 (up to 0.37 mg/L).

Fecal coliform bacteria levels in Waban Brook did not exceed 140 cfu/100ml (representing both dry and wet weather conditions) in any of the seven samples collected (Appendix B, Table B5).

Macroinvertebrate biomonitoring was conducted just downstream from DWM's water quality sampling station (Appendix C). Instream substrates and riparian habitat in this portion of the stream were good, however, low flows precluded the use of RBPIII sampling. WB01 received a habitat assessment score of 155 out of 200.

High water temperature (21.3°C) during the sampling period may explain the absence of non-Trichopteran EPT taxa (Appendix B, Table B3). Due to the qualitative nature of the biomonitoring methodology in this segment, coupled with inconclusive (i.e. not pre-dawn, both low saturation and supersaturation levels) DO data, the entire 0.6 miles of this segment are not assessed for aquatic life.

The aesthetics use is assessed as supported, based on water column clarity, low total suspended solids concentrations, minimal instream vegetative growth, and good overall instream/riparian habitat (Appendix C).

SUMMARY

Designated Uses		Status
Aquatic Life		Not assessed
Fish Consumption		Not assessed
Primary Contact		The entire 0.6 mile length of this segment supports this use.
Secondary Contact		The entire 0.6 mile length of this segment supports this use.
Aesthetics		The entire 0.6 mile length of this segment supports this use.

RECOMMENDATIONS: Waban Brook (Segment MA72-17)

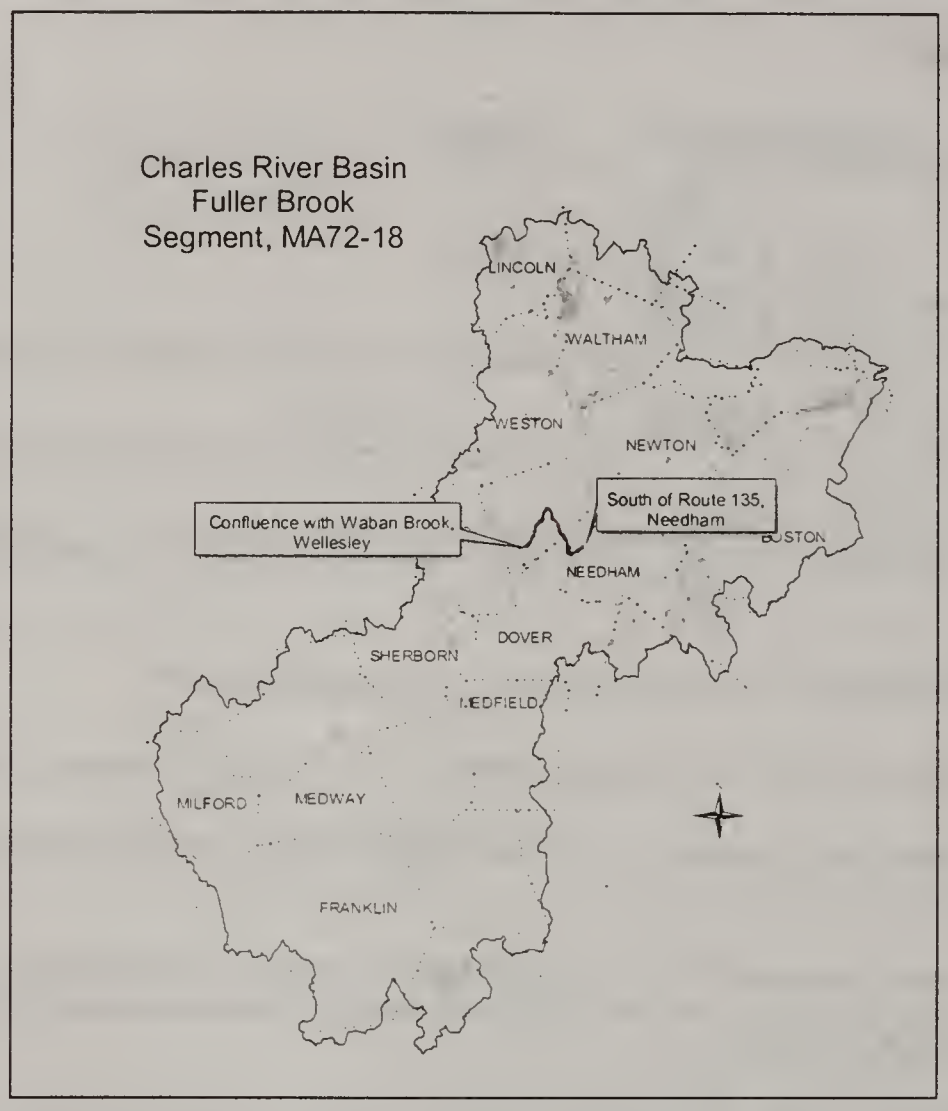
- Improvements to the riparian zone throughout the golf course property (e.g., increase vegetative buffer).
- Additional dissolved oxygen (pre-dawn) and biomonitoring data would be useful in assessing the status of the aquatic life use.
- Investigate potential sources of nutrient loadings to Waban Brook, particularly in the vicinity of the adjacent golf course, as phosphorus levels appeared somewhat elevated near the confluence with the Charles River.

FULLER BROOK (SEGMENT MA72-18)

Location: Headwaters south of Route 135, Needham to confluence with Waban Brook, Wellesley.
Segment length: 4.4 miles. Classification: Class B High Quality Water.

SEGMENT DESCRIPTION

Fuller Brook has a length of approximately two miles and falls 20 feet. From its headwaters near Route 135 and Newman Jr. High School in Needham, Fuller Brook flows in a southwesterly direction through extensive wetlands before heading north towards Wellesley center. The stream continues to flow in a northwesterly direction, draining an area of increasingly heavy residential land use, before receiving the discharge of Caroline Brook and reaching an unnamed impoundment adjacent to Wellesley High School. From here it flows southwest through a heavily developed section of downtown Wellesley. Upon crossing Dover Street in Wellesly, the now channelized stream joins Waban Brook just upstream from the mainstem Charles River.



WITHDRAWALS AND DISCHARGES

NPDES:
1. MA0033022 F. Diehl and Sons

USE ASSESSMENT

The estimate of the 7Q10 discharge in Fuller Brook at the Wellseley College Golf Course is 0.24 cfs (Reis 1999). Streamflow conditions in the brook during the DEP DWM surveys ranged between 0.70 and 12.5 cfs (Appendix B, Table B2).

Fecal coliform data collected by DWM ranged between 40 – 4,000 cfu/100ml collected on 10 dates between July 1997 and April 1998 (Appendix B, Table B5). Additional sampling bracketed an unnamed tributary draining a small impoundment opposite the Wellesley town hall. This impoundment is populated with a large waterfowl population and is a popular "feeding" area. Fecal coliform counts upstream of this tributary did not exceed 200 cfu/100ml whereas counts of 1,600 cfu/100ml were documented downstream of the tributary confluence in Fuller Brook (Appendix B, Table B5). In addition, results from optical brightener screening near Dover Street indicate that high levels of fecal coliform bacteria were not human in origin (Appendix B, Table B6). Both the primary and secondary contact recreational uses are assessed as non-support in the lower 1.0 mile due to elevated bacteria levels originating from the town hall duck pond. It is possible that waterfowl are at least partially responsible for the elevated bacteria levels found on the mainstem Charles River at Charles River Road, just downstream from the Waban Brook (which receives the Fuller Brook discharge near its mouth) confluence. Stormwater and other unknown sources may contribute pathogens as well. The upper 3.4 miles of the segment (from the mouth of the unnamed duckpond tributary to the headwaters near Route 135 in Needham) are not assessed for the primary and secondary contact recreational uses.

Macroinvertebrate biomonitoring was conducted in a sampling reach which extended from Cameron Street to the duck pond tributary's confluence with Fuller Brook (Appendix C). Habitat quality in this portion of Fuller

Brook was good considering the urban nature of this subwatershed. The benthos data revealed the effects of an excessively enriched system. FB02 received a total metric score of 12, only 30% comparable to the regional reference station indicating moderate impairment. The permanent and thriving waterfowl population upstream from the sample reach is the likeliest source of organic inputs to this portion of Fuller Brook. The lower 1.0 miles of Fuller Brook does not support the aquatic life use.

Dissolved oxygen measurements in Fuller Brook ranged between 8.1 and 12.7 mg/L (Appendix B, Table B3). None of these DO measurements were collected before dawn, however, and do not represent worse-case conditions. Physico-chemical sampling data did not indicate water quality impairment (Appendix B, Table B4), however severe habitat degradation was present in the vicinity of the golf course. The upper 3.4 miles of the segment (from the mouth of the unnamed duckpond tributary to the headwaters near Route 135 in Needham) are not assessed for the aquatic life use.

The aesthetics use is supported from the mouth of the unnamed duckpond tributary to Dover Road, Wellesley. The lower 0.3 miles of the segment is not supported due to sediment deposition and excessive amounts of instream vegetation (Appendix C). The upper 3.4 miles of the segment are not assessed.

SUMMARY

Designated Uses		Status
Aquatic Life		Impairment to the macroinvertebrate community and habitat degradation warrant a non-support assessment for aquatic life use for the lower 1.0 miles of this tributary. The upper 3.4 miles of the segment (from the mouth of the unnamed duckpond tributary to the headwaters near Route 135 in Needham) is not assessed for aquatic life use.
Fish Consumption		Not assessed
Primary Contact		The lower 1.0 mile of this segment does not support this use due to pathogens. The upper 3.4 miles of the segment (from the mouth of the unnamed duckpond tributary to the headwaters near Route 135 in Needham) is not assessed.
Secondary Contact		Secondary contact for the lower 1.0 mile of this segment is not supported due to pathogens. The upper 3.4 miles of the segment (from the mouth of the unnamed duckpond tributary to the headwaters near Route 135 in Needham) is not assessed.
Aesthetics		The upper 3.4 miles of the segment is not assessed. The aesthetics life use is supported for 0.7 miles from the mouth of the unnamed duckpond tributary to Dover Road, Wellesley. The lower 0.3 miles of the segment is not supported due to sediment deposition and excessive amounts of instream vegetation.

RECOMMENDATIONS: Fuller Brook (Segment MA72-18)

- Protect and enhance the riparian zone throughout the golf course property (e.g., increase vegetative buffer, improvements to channel morphology).

- Conduct water quality monitoring, biological monitoring and bacteria sampling in the upper 3.4 miles of this segment to better assess the entire segment.

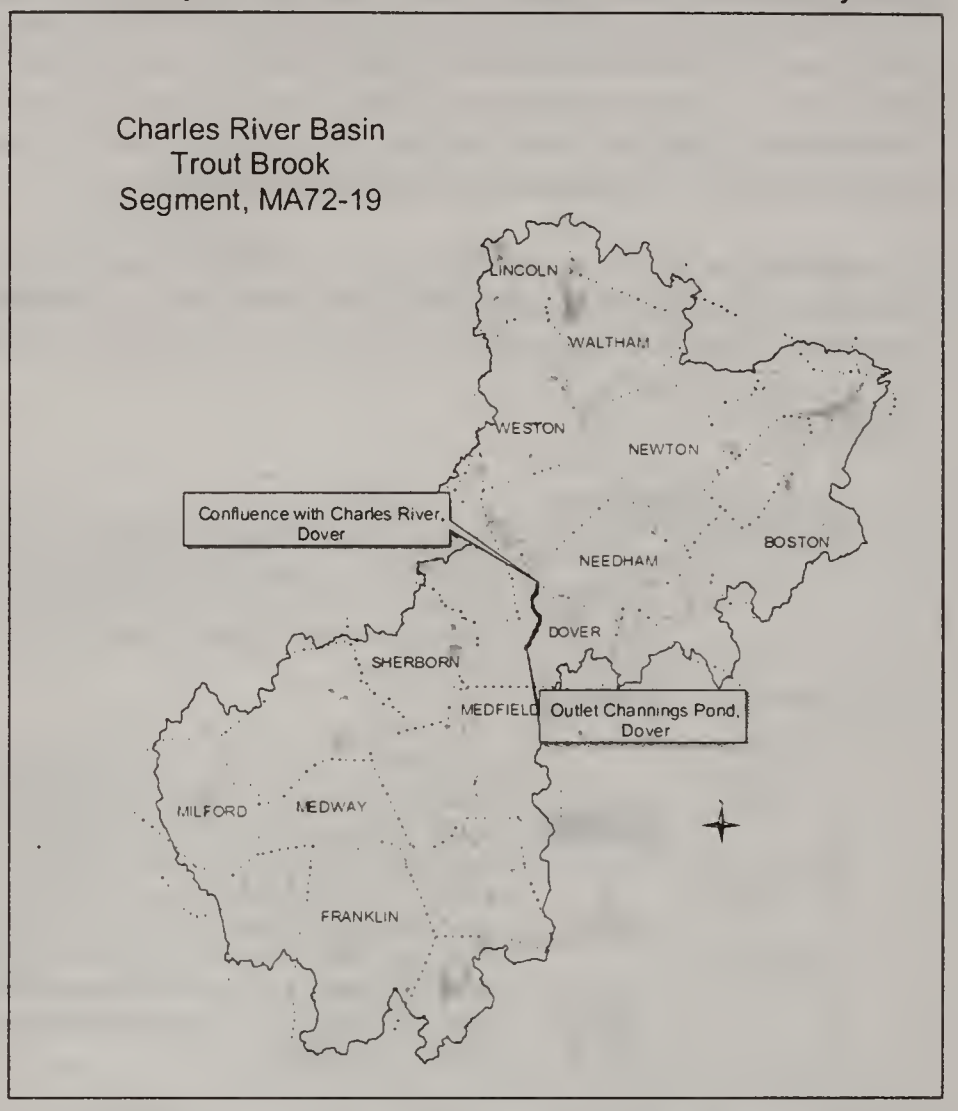
- Address water quality impairment resulting from duck feeding through education and outreach. Strive to minimize or eliminate, if possible, all feeding of waterfowl near the Wellesley town hall. Community involvement through volunteer monitoring is strongly encouraged, as reclamation of Fuller Brook is very feasible and noticeable water quality improvements could be observed immediately.

TROUT BROOK (SEGMENT MA72-19)

Location: Headwaters, outlet Channings Pond, Dover to confluence with Charles River, Dover.
Segment Length: 2.8. Classification: Class B, High Quality Water.

SEGMENT DESCRIPTION

Trout Brook drains a small area of low to medium density residential. The stream flows in a northerly direction through Dover to its confluence with the Charles River in Dover. New home construction is occurring in isolated areas and a new well is being installed on Miller Hill Road in the headwaters. There are several horse farms adjacent to Trout Brook or its tributaries. Agricultural areas (cropland) are adjacent to Trout Brook in the vicinity of Haven Street in the lower portion of the watershed.



WITHDRAWALS AND DISCHARGES

WMA:

1. Public groundwater withdrawal 307800-03G
2. Public groundwater withdrawals 3078008-01G and 3078008-02G in Dover

USE ASSESSMENT

Sampling in the Trout Brook watershed was conducted as part of the IM3 Project on one date 20 November 1996 at 11 stations although only one was located directly in Trout Brook (CRWA 1997a). DWM sampled Trout Brook near Haven Street in Dover on eight different occasions between July 1997 and April 1998. Fecal coliform data collected ranged from less than 10 to 360 cfu/100ml (Appendix B, Table B5). Primary and secondary contact recreational uses are therefore assessed as support. The lowest discharge during the DWM surveys in Trout Brook was on 20 August 1997. The discharge was 0.45 cfs (Appendix B, Table B2).

The instream temperatures in Trout Brook were the coolest measured by DWM in the Charles River Watershed (Appendix B, Table B3). This stream, although not classified as Cold Water Fishery, does support a native eastern brook trout population. The Department of Fisheries, Wildlife and Environmental Law Enforcement (DFWELE) also stocks this stream with brown trout.

Dissolved oxygen measurements were recorded between 0846h and 1230h by DWM and therefore do not represent worse-case conditions (Appendix B, Table B3). The DO ranged between 6.0 and 12.0 mg/L although saturation was below 60% one occasion. Saturation was near 60% (61 and 62%) on two other sampling events. Other physicochemical and nutrient variables monitored appeared to indicate generally good water quality conditions (Appendix B, Table B4).

Macroinvertebrate biomonitoring in Trout Brook was conducted downstream from Haven Street at station TB01 (Appendix C). Despite the excellent habitat available, the benthic community analysis found an assemblage only 30% comparable to reference conditions at ST01. Particularly alarming were the lack of EPT taxa and a dominance of the assemblage by the Chironomidae, which contributed to the moderate impairment evaluation. Potential causes of impairment are unknown; however, low levels of dissolved oxygen and possible pesticide inputs to this portion of the stream should be considered. The periphyton community

analysis conducted by DWM at this station corroborates potential pesticide effects on the biological community in this portion of Trout Brook (Appendix C). Another practice associated with agricultural activities that may impact biological integrity in Trout Brook is the use of fertilizers. The chironomid *Tvetenia Bavarica*, the dominant taxon in the TB01 assemblage, has been shown to prefer cool-water streams exhibiting nutrient-enriched conditions (Bode and Novak 1998). The application of fertilizers to adjacent crops, as well as other sources of non-agricultural nutrient loadings, should be a concern in this portion of Trout Brook. Based on the RBPIII analysis, the aquatic life use is non-supported for the entire 2.8 miles of this segment.

Aesthetic quality, as evidenced by good water clarity, low total suspended solids and low turbidity, and good habitat quality, is supported for the entire 2.8 miles of this segment.

SUMMARY

Designated Uses		Status
Aquatic Life		Aquatic life use is non-supported for the entire 2.8 miles of this segment. Causes are unknown, but potentially may be low dissolved oxygen and pesticides.
Fish Consumption		Not assessed
Primary Contact		Primary contact recreational uses are assessed as support for the entire 2.8 miles of this segment.
Secondary Contact		Secondary contact recreational uses are assessed as support for the entire 2.8 miles of this segment.
Aesthetics		The entire 2.8 miles of the segment supports the aesthetics use.

RECOMMENDATIONS: Trout Brook (Segment MA72-19)

- Monitor dissolved oxygen continuously during the summer (low-flow) months at a minimum of one station in the lower portion of the Trout Brook subwatershed to assist with future aquatic life use assessments, and to establish more accurate baseline conditions.

- Require proper manure storage and handling at farms (horse and/or agricultural) in the Trout Brook Subwatershed. Manure should not be stored in the riparian zone of Trout Brook.

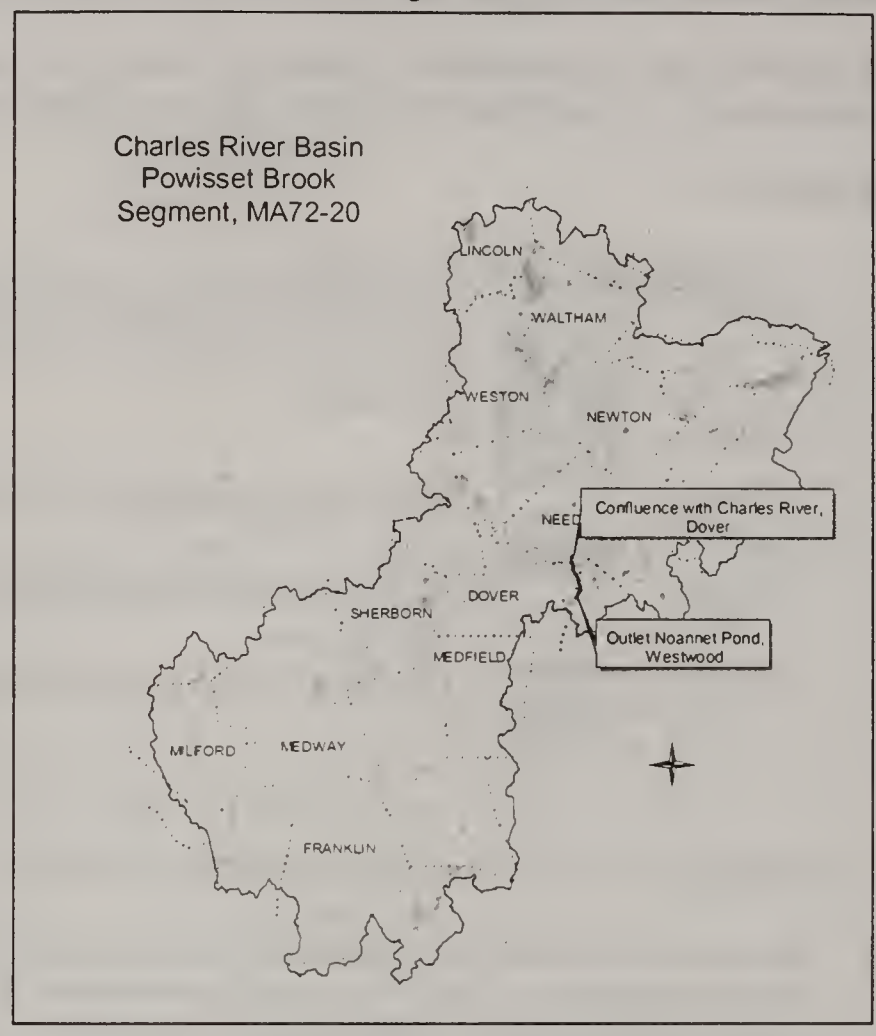
- Conduct a NPS evaluation in the Trout Brook Subwatershed to identify possible sources of nutrients and pesticides from both agricultural and non-agricultural land use activities.

POWISSETT BROOK (SEGMENT MA72-20)

Location: Outlet Noannet Pond, Westwood to confluence with Charles River, Dover.
Segment Length: 1.9 miles. Classification: Class B High Quality Water

SEGMENT DESCRIPTION

Powissett Brook drains a small area of mostly forested land and minimal light residential land use. From the headwaters in Noannet Pond, the stream flows in a generally northerly direction before joining the Charles River in Dover.



WITHDRAWALS AND DISCHARGES

None known.

USE ASSESSMENT

Bacteria sampling in Powissett Brook was conducted by DWM on four occasions between July 1997 and April 1998 (Appendix B, Table B5). Stream discharge was extremely low on several occasions during the summer of 1997 (Appendix B, Table B2 and B5). Fecal coliform data collected at Wilsondale Road ranged from less than 20 to 40 cfu/100ml. Based on these data, coupled with the land use observations during field reconnaissance (forested), the primary and secondary contact recreational uses are therefore assessed as support for the entire 1.9 miles of this segment.

Dissolved oxygen measurements in Powissett Brook were all made between 1030h and 1130h and therefore do not represent worse-case conditions. DO levels ranged between 1.1 and 12.6 mg/L with saturation as low as 13% on one occasion (Appendix B, Table B3). Excessively low levels of dissolved oxygen may be a reflection of the extremely low baseflow conditions (possibly naturally occurring, as water withdrawals are absent in this watershed), when Hydrolab™ readings were taken from virtually standing pools of water. Although nutrient levels appeared normal, additional physico-chemical parameters indicate a poorly buffered system vulnerable to acidification. Measurements of pH (range of 5.3 and 6.1 SU), alkalinity (3-11), and hardness (10-16) represent some of lowest levels in the entire Charles River Watershed (Appendix B, Table B4).

Macroinvertebrate biomonitoring was conducted by DWM on 16 July 1997 in a reach (PB01) downstream from Wilsondale Road in Dover (Appendix C). The low percent comparability (45%) to reference conditions in Stony Brook resulted in a moderately impaired benthos assessment. Fish population sampling conducted in the shallow and limited pool habitat available in Powissett Brook yielded only 2 chain pickerel (*Esox niger*) which probably originated from the upstream impoundment (Appendix C). It is unknown, however, whether benthic impairment is the result of naturally occurring low flows or exacerbated by the upstream dams. Based on the abundance of "clean-water" macroinvertebrate taxa collected at PB01, the aquatic life use is assessed as support for the entire 1.9 miles of this stream.

Based on good instream and riparian habitat quality, good water column clarity, low total suspended solids and low turbidity, and minimal aquatic vegetative cover throughout the segment, the aesthetic use is supported for the entire 1.9 miles of the segment.

SUMMARY

Designated Uses		Status
Aquatic Life		Aquatic life use is assessed as support for the entire 1.9 miles of this stream.
Fish Consumption		Not assessed
Primary Contact		Primary contact recreational use is assessed as support for the entire 1.9 miles of this segment.
Secondary Contact		Secondary contact recreational use is assessed as support for the entire 1.9 miles of this segment.
Aesthetics		The entire 1.9 miles of the segment supports the aesthetics use.

RECOMMENDATIONS: Powissett Brook (Segment MA72-20)

- Conduct diurnal dissolved oxygen monitoring and (RBPIII) biological sampling to establish baseline biological conditions that will aid in future aquatic life use assessments.

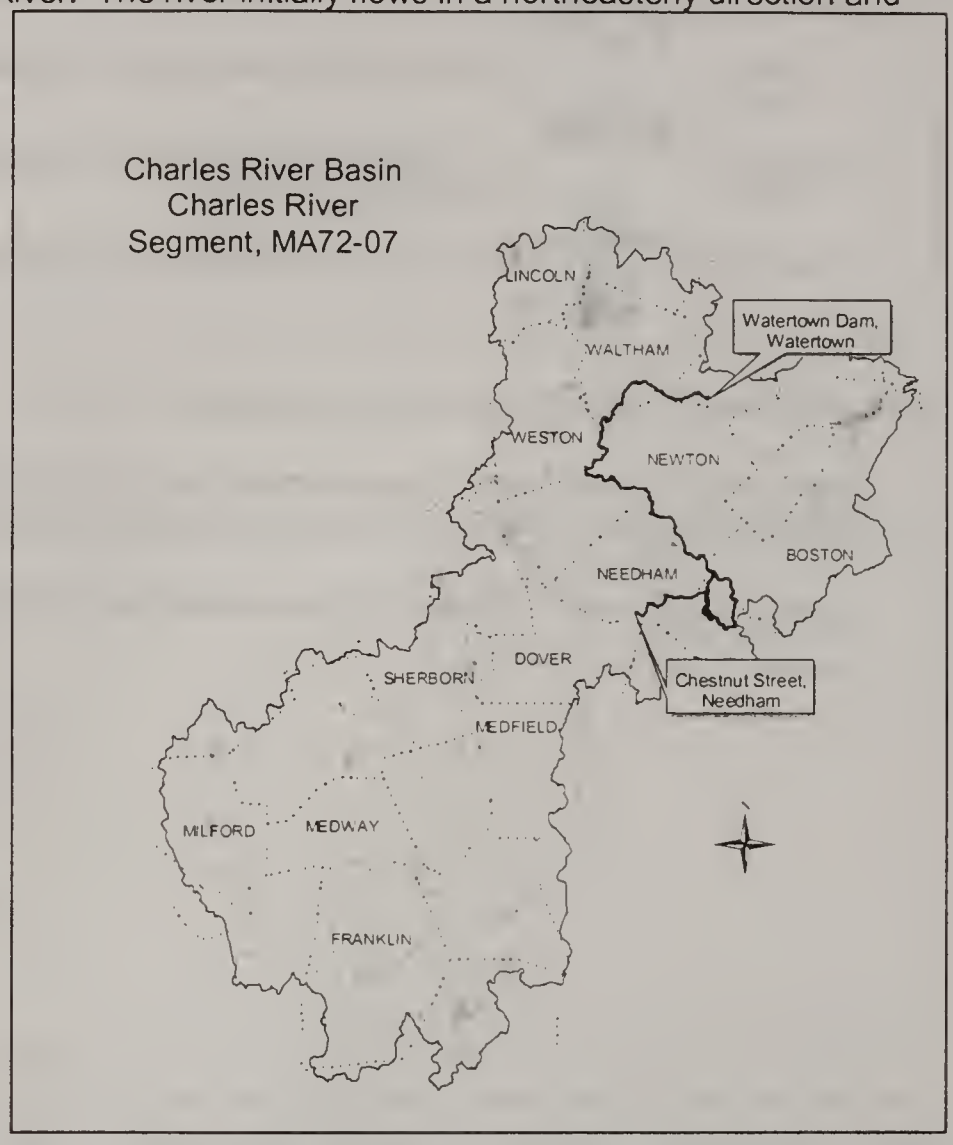
- Investigate the presence/extent of dams along Powissett Brook and their impacts on flow.

CHARLES RIVER (SEGMENT MA72-07)

Location: Chestnut Street, Needham to Watertown Dam, Watertown. Segment Length: 23.2 miles.
Classification: Class B, Warm Water Fishery.

SEGMENT DESCRIPTION

This is the longest segment of the Charles River. The river initially flows in a northeasterly direction and then enters the "Dedham Loop". Once into the "Dedham Loop" the river flows south and approaches the Neponset River Basin drainage divide. Here the Mother Brook Diversion is capable of diverting up to one-third the flow of the Charles River into the Neponset River (a flood control capability) via Mother Brook. The Charles River then turns in a northwesterly direction, flows over a series of dams in the Newton/Needham/Wellsley area and then forms the "Lakes District". As it leaves this series of impounded waters, the river flows in an easterly direction before reaching the Watertown Dam in Watertown. While considerable tracts of wetlands still exist in the vicinity of the Dedham Loop, the majority of this segment is extremely urbanized with a wide range of residential, industrial, and commercial land uses.



WITHDRAWALS AND DISCHARGES

WMA:

1. Public groundwater withdrawals 3073000-01G, 3073000-02G, 3073000-03G, 3073000-04G, and 3073000-05G in Dedham
2. Public groundwater withdrawals 3333000-03G and 3333000-04G in Weston

NPDES:

1. MA0027561 Norfolk and Dedham Mutual Fire
2. MA0031283 Dedham Medical Associates Addition
3. MA0032425 Arthur Blank and Company
4. MA0032921 Gulf Service Station, Needham
5. MA0003719 Ivex Corporation
6. MA0035181 Shipley Company
7. MA0030449 Raytheon Company
8. MA0005631 Barry Division, Barry Wright Corporation

USE ASSESSMENT

CRWA conducted water quality monitoring at twelve locations in this segment between 16 October 1995 and 17 December 1997 (CRWA 1998). Their most downstream sampling location was at the Watertown Dam. DWM also sampled water quality at the Watertown Dam between 1 July 1997 and 22 November 1997. MWRA has also monitored water quality at the Watertown Dam since 1989. During their 22 sampling events, the IM3 Project documented fecal coliform levels (dry weather conditions) ranging from <10 cfu/100ml to 1270 cfu/100ml, while DWM fecal coliform densities ranged between 100 cfu/100ml and 360 cfu/100ml

(CRWA 1998 and Appendix B, Table B5, respectively). Due to several exceedences (none of which indicate spatial or temporal trends in elevated bacteria levels) of 400 cfu/100ml, the primary contact use is assessed as non-support. Wet weather sampling was conducted at the above twelve stations during fifteen sampling events between 3 September 1996 to 29 October 1997 with fecal coliform levels ranged from 20 cfu/100ml to 78,000 cfu/100ml (CRWA 1998). DWM did not conduct wet weather sampling in this segment. While fecal coliform bacteria levels were less than 2,000 cfu/100ml during dry weather conditions, wet weather data were greater than 4,000 cfu/100ml. The secondary contact recreational use is therefore assessed as partial support.

Dissolved oxygen measurements upstream of the Watertown Dam did not meet standards (Table 3) on two occasions—14 July and 20 August 1997. These data do not represent worse-case (pre-dawn) conditions. Brandeis University conducted water quality monitoring in the Charles River Lakes District as part of the IM3 Project, documenting extreme diurnal variation in oxygen saturation, elevated levels of nutrients (particularly phosphorus) and high chlorophyll *a* concentrations (CRWA 1997a). Cram's Cove exhibited particularly poor water quality.

Since this segment encompasses such a large section of the Charles River, and the majority of the current water quality monitoring data exists only between the Lakes District and the Watertown Dam, the aquatic life use assessment is based in part on an extrapolation of the upstream segment MA72-06 assessment and best professional judgement. The upper 17.4 miles partially support the aquatic life use. Downstream from Route 30, Newton, the Charles River is assessed as not supporting the aquatic life use (5.8 miles).

The aesthetic quality of the Charles River is assessed as partial support in the upper 17.4 miles of this segment based on the presence of nuisance aquatic vegetation and moderate turbidity. Addtionally, there is excessive growth of non-native macrophytes including 38% cover of *Trapa natans* (CRWA 1997a). The aesthetic use for the lower 5.8 mile length of this segment is assessed as non-support. Moderate levels of turbidity throughout the Lakes District and downstream to the Watertown Dam corroborates this assessment (Fiorentino 1998). Based on these data, the secondary contact recreational use is also assessed as non-support for the lower 5.8 miles.

In August 1994, DEP DWM collected fish from this segment of the Charles River, at the request of a concerned citizen. DPH reviewed the results of the fish toxics monitoring data and subsequently issued a consumption advisory because of elevated levels of PCB in common carp (DPH 1998). The fish consumption use is therefore assessed as non-support for this segment.

Sediment quality monitoring was conducted as part of the IM3 Project. EPA conducted sediment sampling at three stations (CRWA05, CRWA06, CRWA07) in this segment of the mainstem Charles River in May 1996, while Brandeis University collected sediments at two stations from both Cram's and Purgatory Coves in the Charles River Lakes District. Elevated concentrations of pesticides, heavy metals, and/or PCB were measured in these samples (CRWA 1997a). No acute toxicity, however, was detected where acute sediment toxicity testing was performed.

SUMMARY

Designated Uses		Status
Aquatic Life		The lower 5.8 miles of this segment do not support this use. The upper 17.4 miles of this segment are assessed as partial support. Causes of impairment are organic enrichment/low DO, and nutrients.
Fish Consumption		The entire 23.2 miles of this segment does not support the fish consumption use since DPH has issued a fish consumption advisory because of elevated levels of PCB in carp.
Primary Contact		The entire 23.2 miles length of this segment does not support this use because of elevated levels of fecal coliform bacteria during dry weather conditions.
Secondary Contact		The upper 17.4 miles of this segment partially supports the secondary contact recreational use due to elevated bacteria levels during storm events. The lower 5.8 miles of this segment do not support this use as a result of dense macrophyte cover.
Aesthetics		The upper 17.4 miles of this segment are assessed as partial support for the aesthetics use, based on the presence of non-native aquatic vegetation and turbidity. The lower 5.8 miles of this segment do not support this use, based on the presence of non-native aquatic vegetation and turbidity.

RECOMMENDATIONS: Charles River (Segment MA72-07)

- Diurnal DO and biological monitoring (RBPIII), as well as nutrient, chlorophyll *a* and periphyton sampling are recommended in the upper 17.4 miles of this segment to establish baseline conditions and aid with future aquatic life use assessments.

- Attempt to isolate sources of elevated fecal coliform bacteria inputs to the Charles River, from stormwater runoff, illicit sewer connections to those tributaries between Moody Street and the Watertown Dam, and waterfowl feces.

- Minimize (rather than encourage) the feeding of waterfowl in the Lakes District.

- Attempt to control the growth and spreading of nuisance aquatic vegetation (particularly *Trapa natans*) in the lower 5.8 miles of this segment, especially in the Lakes District. Develop a long-term management plan to control the nuisance vegetation.

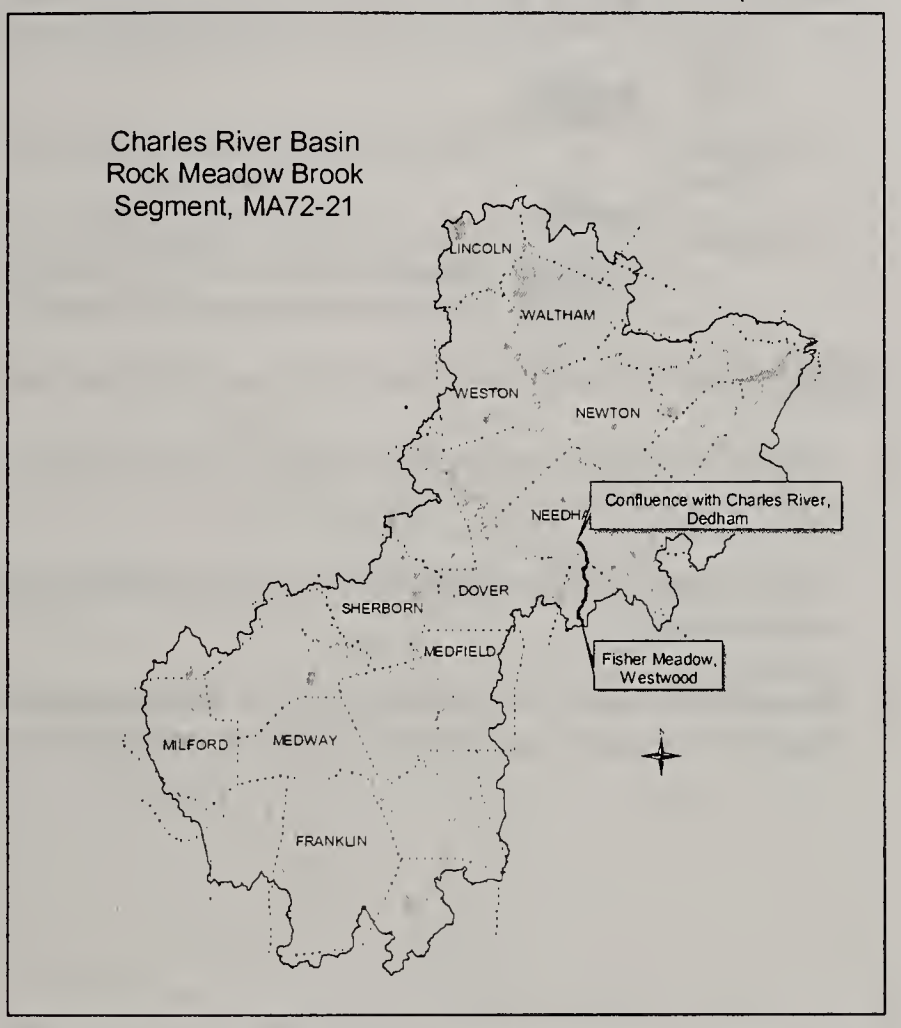
- As part of EPA Clean 2005 initiative, EPA has initiated an annual monitoring program that will include dry and wet weather sampling in the Charles River Watershed during summer months (high recreational usage).

ROCK MEADOW BROOK (SEGMENT MA72-21)

Location: Headwaters in Fisher Meadow, Westwood to confluence with Charles River, Dedham.
Segment Length: 3.8 miles. Classification: Class B.

SEGMENT DESCRIPTION

Rock Meadow Brook originates in a wetland called Fisher Meadow in suburban Westwood. The predominant land use in the upper reaches of its watershed is dense residential development. The brook flows in a generally northerly direction through two impoundments, Stevens and Lee Ponds. Land use in the lower watershed includes forests, a golf course (the Dedham Country Club) and very little residential use. Rock Meadow Brook flows generally west to its confluence with the mainstem Charles River in Dedham.



WITHDRAWALS AND DISCHARGES

WMA:

1. Two municipal (Westwood) public water supply groundwater sources (307300010-G and 307300012-G) are located in close proximity to Rock Meadow Brook south of the Stevens Pond impoundment. These two sources are currently inactive.

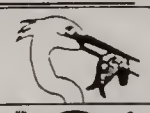
USE ASSESSMENT

Streamflow measurements were collected on Rockmeadow Brook on five occasions between June 1997 and April 1998 ranging from extremely low (estimated 0.00 cfs) to 7.13 cfs (Appendix B, Table B2). DEP DWM conducted stream water quality sampling in Rock Meadow Brook (station RM01) was conducted by DWM on seven occasions between June 1997 and April 1998. Fecal coliform bacteria sampling data ranged between <20 and 600 cfu/100 mls (Appendix B, Table B%) and therefore the primary contact recreational use was not supported (a result of exceedences during dry weather). The secondary contact recreational use was assessed as support for the length of the 3.8 mile segment.

Dissolved oxygen measurements in Rock Meadow Brook were all made between 930 and 1100 and therefore do not represent worse-case conditions. DO levels ranged between 6.6 and 13.0 mg/L with saturation as low as 71% to 96% (Appendix B, Table B3). Other physico-chemical and nutrient parameters monitored appeared to indicate generally good water quality conditions, although phosphorus levels were moderately elevated (Appendix B, Table B4). Macroinvertebrate biomonitoring was conducted at DWM's water quality monitoring station, however, limited summer flows in this portion of the stream precluded quantitative sampling. Results of a cursory benthos screening conducted 16 July 1997 found no gross impairment to the resident aquatic community (Appendix C). Low instream flows, observed throughout the summer, were probably a natural occurrence rather than the result of upstream groundwater withdrawals (Appendix B, Table B2). Based on the water quality and biosurvey (incuding habitat) data collected in Rock Meadow Brook, the entire 3.8 miles of this segment are assessed as support for the aquatic life use.

Based on good instream and riparian habitat quality, good water column clarity, low dry weather total suspended solids, low turbidity, and minimal aquatic vegetative cover throughout the segment, the aesthetic use is assessed as support for the entire 3.8 miles of the segment (Appendix B, Table B4 and Appendix C).

SUMMARY

Designated Uses		Status
Aquatic Life		Entire 3.8 miles is assessed as support for aquatic life use based on generally good water quality and a minimally impaired resident aquatic community
Fish Consumption		Not assessed
Primary Contact		Entire 3.8 miles is assessed as non-support for primary contact due to pathogens.
Secondary Contact		Secondary contact use is supported for the length of the 3.8 miles segment.
Aesthetics		Based on instream and riparian habitat quality, good water column clarity, low total suspended solids low turbidity, and minimal aquatic vegetative cover throughout the segment, the aesthetic use assessment supports for the entire 3.8 miles of the segment.

RECOMMENDATIONS: Rock Meadow Brook (Segment MA72-21)

- Conduct additional upstream sampling to isolate sources of elevated fecal coliform bacteria during dry weather conditions.

- Conduct diurnal DO monitoring to establish baseline conditions that will aid in future aquatic life use assessments.

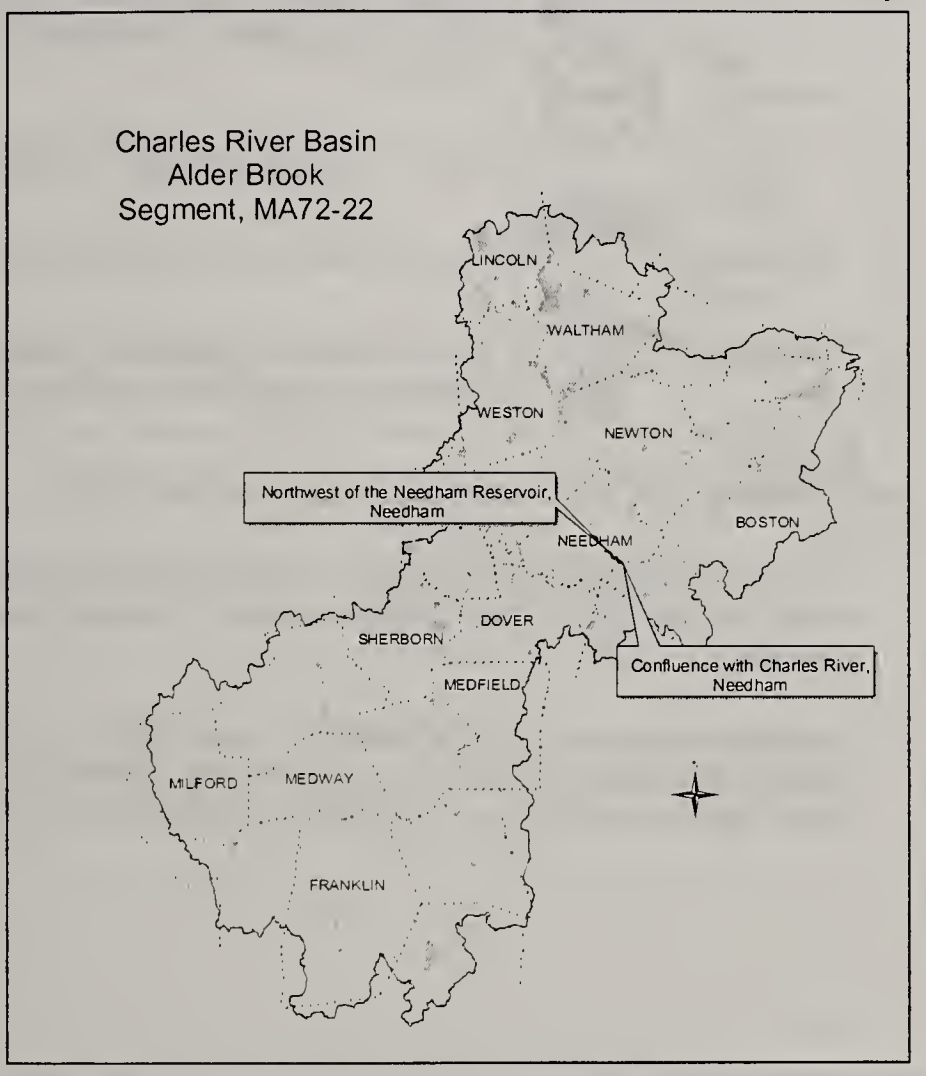
- Establish a water quality station closer to the confluence with the Charles River, particularly downstream from the Dedham Country Club. Evaluate any potential runoff effects from the country club.

ALDER BROOK (SEGMENT MA72-22)

Location: Headwaters northwest of Needham Reservoir, Needham to confluence with Charles River, Needham. Segment Length: 0.7 miles. Classification: Class B.

SEGMENT DESCRIPTION

From its headwaters near Pollard Jr. High School in Dedham Center, Alder Brook flows in a southeasterly direction and adjacent to Dedham Avenue. Upstream from South Street the stream receives considerable drainage from Needham Reservoir and an unnamed tributary that originates upstream from the reservoir. From this confluence, Alder Brook soon joins the mainstem Charles River just upstream from the Dedham Avenue Bridge. Heavy to moderate residential and commercial land use are prevalent along much of the segment, while large tracts of recreational space (playground and golf course) comprise the remainder of the drainage area.



WITHDRAWALS AND DISCHARGES

None known.

USE ASSESSMENT

Stream discharge measurements in Alder Brook were collected between June 1997 and April 1998. The stream discharges ranged from 1.06 to 2.99 cfs (Appendix B, Table B2).

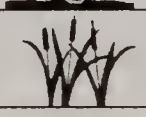
DWM conducted water quality sampling in Alder Brook at South Street (AB01) on eight occasions between 17 June 1997 and 22 April 1998.

Elevated levels of fecal coliform bacteria impair the primary contact recreational use (as high as 1,280 cfu/100ml during dry weather) for the entire 0.7 miles of this segment (Appendix B, Table B5). The secondary contact recreational use, for the entire 0.7 miles is assessed as support.

Macroinvertebrate and fish sampling in Alder Brook was conducted by DWM downstream from South Street in July 1997 (Appendix C). Although the habitat evaluation resulted in an assessment score (159) that was higher than the regional reference station ST01, the benthic macroinvertebrate community was only 45% comparable to reference conditions indicating moderate impairment. An abundance of filter-feeding Hydropsychidae suggests somewhat organically enriched conditions, possibly originating from Needham Reservoir. Results of fish sampling, which indicate a community dominated by warm-water taxa (especially pumpkinseed, *Lepomis gibbosus*), also suggests the impoundments upstream may shape community structure and function in this portion of the stream. Nutrient levels were slightly elevated, with total phosphorus concentrations ranging from 0.02-0.09 mg/L and ammonia-nitrogen as high as 0.14 mg/L on one occasion (Appendix B, Table B4). Other water quality and physico-chemical parameters—including dissolved oxygen—were normal. Based on impairment to the macroinvertebrate community, the aquatic life use is assessed as non-support for the entire 0.7 miles of this segment. Although the causes of impairment are unknown, organic enrichment and nutrient loadings originating from various NPS inputs are suspected.

The aesthetics use is assessed as support for the entire 0.7 miles of this segment based on good instream and riparian habitat, minimal aquatic vegetative growth, and low turbidity (Fiorentino 1998).

SUMMARY

Designated Uses		Status
Aquatic Life		The aquatic life use is assessed as non-support for the entire 0.7 miles of this segment. Causes of impairment to aquatic life are unknown although most likely related to organic enrichment and nutrient loadings originating from various NPS inputs.
Fish Consumption		Not assessed
Primary Contact		The entire 0.7 miles of this segment is assessed as non-support due to pathogens.
Secondary Contact		This use is assessed as support for the entire 0.7 miles of this segment.
Aesthetics		The aesthetics use is assessed as support for the entire 0.7 miles of this segment based on good instream and riparian habitat, minimal aquatic vegetative growth, and low turbidity.

RECOMMENDATIONS: Alder Brook (Segment MA72-22)

- Future monitoring for fecal coliform bacteria should bracket the impoundments and land use changes within this drainage area to isolate sources of elevated bacteria and nutrients during dry weather conditions.

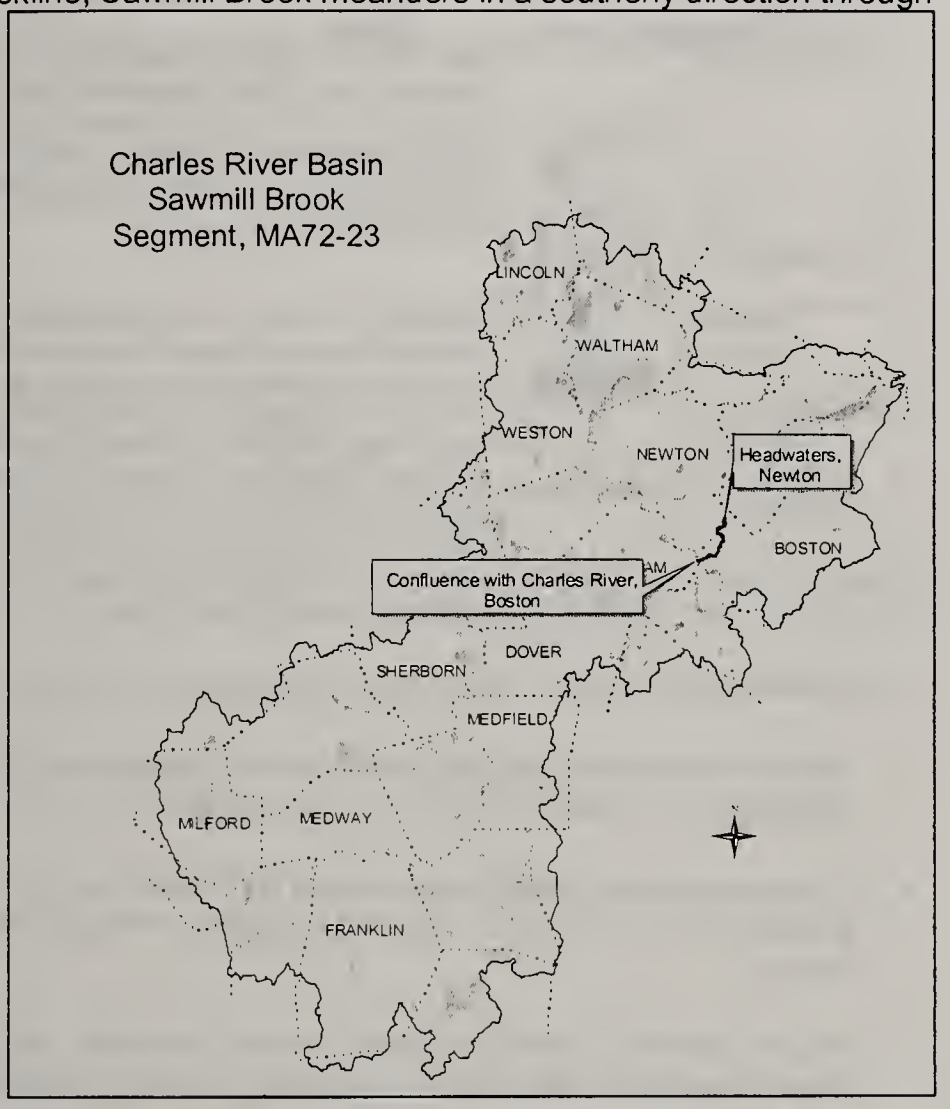
- Attempt to isolate land use activities in this system which may contribute to instream organic/nutrient inputs that adversely affect biological integrity. Identify and implement BMP's where runoff may pose a threat to water quality (e.g., non-buffered recreational spaces adjacent to the stream).

SAWMILL BROOK (SEGMENT MA72-23)

Location: Headwaters, Brookline to confluence with Charles River, Boston. Segment Length: 2.7 miles.
Classification: Class B.

SEGMENT DESCRIPTION

From its headwaters near Vine Street in Brookline, Sawmill Brook meanders in a southerly direction through an area of moderate to heavy residential land use and open space. Downstream from the Middlesex/Suffolk County border, the stream flows through a large tract of land occupied by several cemeteries before draining a large wetland and joining the Charles River.



WITHDRAWALS AND DISCHARGES

None permitted.

USE ASSESSMENT

Stream discharge measurements in Sawmill Brook between June 1997 and April 1998 ranged between 0.1 and 2.71 cfs (Appendix B, Table B2). Bacteria sampling in Sawmill Brook was conducted by DWM near Baker Street on seven occasions between July 1997 and April 1998 and at two upstream stations on 1 January 1998 (Appendix B, Table B5). Elevated fecal coliform bacteria levels (520 - 7000 cfu/100ml) were measured downstream from the storm drain discharge located in St. Joseph's Cemetery (approximately 100-200m upstream from Baker Street) in Boston. The fecal coliform count immediately upstream from this stormdrain was only 200 cfu/100ml. Consistently positive results from optical brightener screening near Baker Street supports the belief that fecal coliform bacteria inputs are of human origin, likely via illicit discharges in the storm drain system (Appendix B, Table B6).

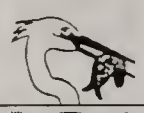
Nutrient levels measured at Baker Street were elevated, with phosphorus concentrations as high as 0.27 mg/L and ammonia-nitrogen as high as 0.90 mg/L. Chlorides were also elevated, ranging from 95-220 mg/L, as was conductivity (as high as 860 µS/cm). Instream dissolved oxygen levels, during the seven sampling events, ranged from <1.0 mg/L (7% saturation) to 11.1 mg/L (Appendix B, Tables B4 and B3 respectively).

Based on severe water quality degradation to Sawmill Brook (low DO, elevated nutrients and chlorides) downstream from the storm drain outfall near Baker Street and habitat modifications (i.e., channelization, removal of riparian vegetation) throughout St. Joseph's Cemetery (Fiorentino 1998), the lower 1.8 miles are assessed as non-support for aquatic life. The aquatic life use is not assessed in the upper 0.9 miles of Sawmill Brook.

Primary and secondary contact recreation is assessed as non-support for the lower 1.3 (from the storm drain discharge to the confluence with the Charles River) miles of this segment due to pathogens associated with dry weather storm drain discharge. The upper 1.4 miles (from the headwaters to St. Joseph's Cemetery) are not assessed for these recreational uses.

The aesthetics use is not supported for the lower 1.8 miles (from the headwaters to St. Joseph's Cemetery) of Sawmill Brook based on sewage odors, dense instream aquatic vegetation (especially downstream from Baker Street), sediment deposition, and turbidity (Appendix B, Table B4).

SUMMARY

Designated Uses		Status
Aquatic Life		The upper 0.9 (from the headwaters to St. Joseph's Cemetery) miles are not assessed. Based on severe water quality degradation (low DO, nutrients, unknown) downstream from the stormdrain outfall near Baker Street and habitat modifications (i.e., channelization, removal of riparian vegetation) throughout St. Joseph's Cemetery, the lower 1.8 miles of Sawmill Brook are assessed as non-support for the aquatic life use.
Fish Consumption		Not assessed
Primary Contact		The upper 1.4 miles are not assessed for this use. The lower 1.3 (from the stormdrain discharge to the confluence with the Charles River) miles of this segment are assessed as non-support for this use due to pathogens associated with dry weather stormdrain discharge.
Secondary Contact		The upper 1.4 miles are not assessed for this use. The lower 1.3 (from the stormdrain discharge to the confluence with the Charles River) miles of this segment are assessed as non-support for secondary contact due to pathogens associated with dry weather stormdrain discharge.
Aesthetics		The upper 0.9 miles are not assessed for this use. The aesthetics use is not supported for the lower 1.8 miles (from the headwaters to St. Joseph's Cemetery) of Sawmill Brook based on sewage odors, dense instream aquatic vegetation (especially downstream from Baker Street), sediment deposition, and turbidity.

RECOMMENDATIONS: Sawmill Brook (Segment MA72-23)

- Infrastructure repairs/upgrades are strongly recommended to eliminate the dry weather storm drain discharge(s) to Sawmill Brook in St. Joseph's Cemetery.

- Conduct surveys to identify sources of NPS runoff and sedimentation to Sawmill Brook. Once sources are identified, BMP implementation is recommended to reduce runoff and sediment inputs into Sawmill Brook.

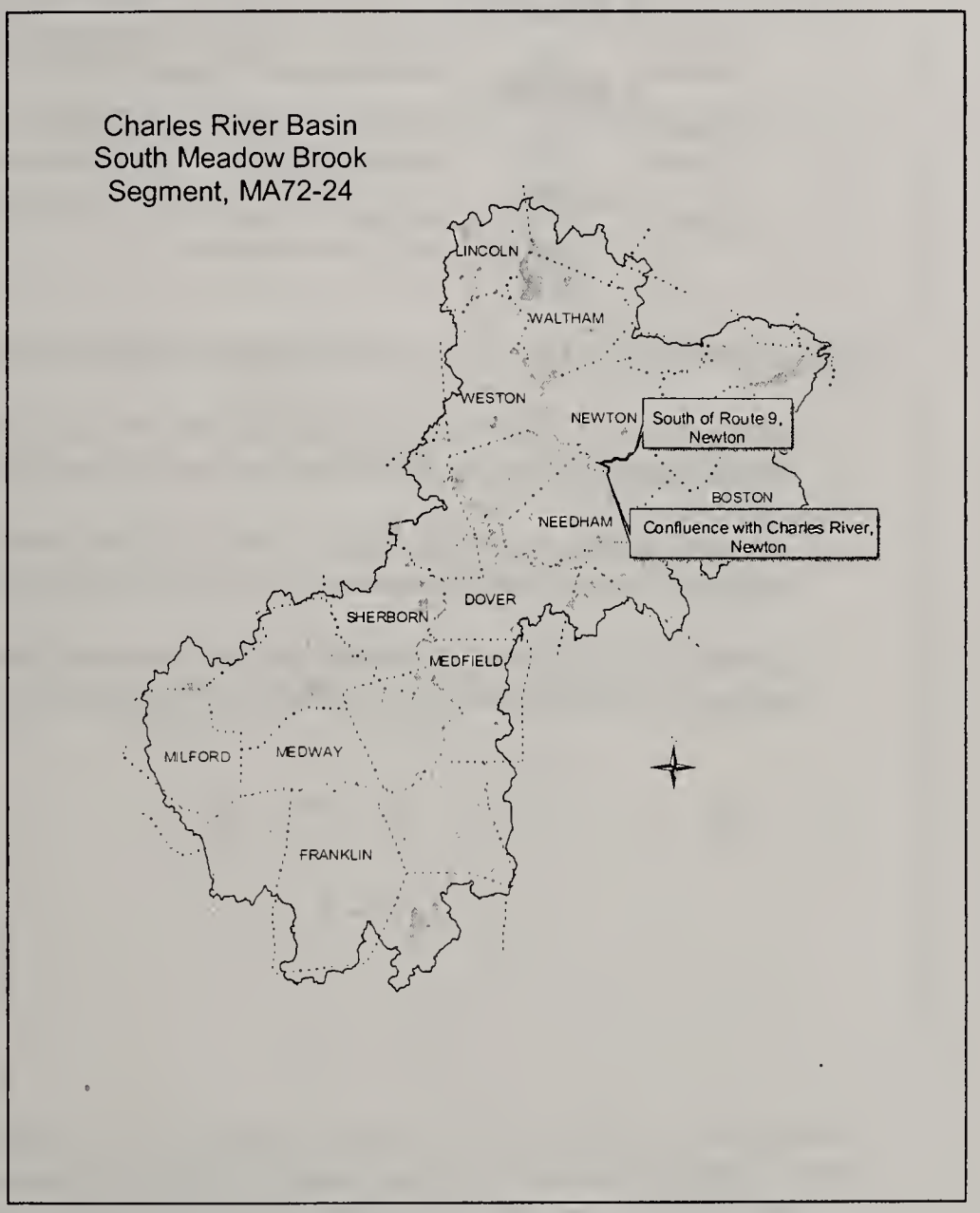
- Future monitoring of fecal coliform bacteria, nutrients, and other physico-chemical parameters is recommended in Sawmill Brook at Baker Street, as well as two locations which bracket the storm drain pipe which discharges to the brook in St. Joseph's Cemetery.

SOUTH MEADOW BROOK (SEGMENT MA72-24)

Location: Headwaters, south of Route 9, Newton to confluence with Charles River, Newton.
Segment Length: 2.1 miles. Classification: Class B.

SEGMENT DESCRIPTION

From its headwaters near Route 9 in Newton, South Meadow Brook flows in a generally westerly direction through an area of heavy commercial and residential land use. Just downstream from Needham Street in Newton the stream disappears underground as it heads in a southerly direction until its confluence with the Charles River. South Meadow Brook is one of the most urbanized streams in the entire Charles River Watershed.



WITHDRAWALS AND DISCHARGES

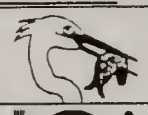
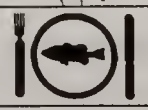
NPDES:
1. MA0036307 Atrium at Chestnut Hill

USE ASSESSMENT

Stream discharge measurements in South Meadow Brook between June 1997 and April 1998 ranged between 0.11 and 2.62 cfs (Appendix B, Table B2). DWM conducted water quality sampling downstream from Needham Street in Newton on ten occasions between 17 June 1997 to 22 April 1998. Fecal coliform bacteria levels ranged from 200 to 3600 cfu/100ml, thereby impairing the primary and secondary recreation uses (Appendix B, Table B5). The entire 2.1 miles of this segment are assessed as non-support for these uses because of elevated pathogens. Positive results from optical brightener screening (Appendix B, Table B6) supports this assessment, and suggests that high levels of fecal coliform bacteria are human in origin and probably enter the stream via illicit discharges in the storm drain system.

Dissolved oxygen levels as low as 3.6 mg/L (35% saturation), elevated ammonia-nitrogen (0.26 mg/L) and phosphorus (0.20 mg/L) concentrations, and occasionally high levels of chlorides and suspended solids also indicate severely degraded water quality in this stream (Appendix B, Tables B3 and B4). Additional impairment to aquatic life is evident in the form of habitat modifications (channelization, reduction of riparian zone) and significant deposits of sand and silt throughout the stream. Other NPS inputs (e.g., trash, road/railroad runoff) resulting from the urbanized nature of this stream system were also observed (Fiorentino 1998). Based on the severely impaired habitat and physico-chemical conditions documented, both the aquatic life and aesthetics uses are assessed as non-support for the entire 2.1 miles of South Meadow Brook.

SUMMARY

Designated Uses		Status
Aquatic Life		The entire 2.1 miles of this segment are assessed as non-support due to poor water quality (organic enrichment/low DO, nutrients) and degraded habitat.
Fish Consumption		Not assessed
Primary Contact		For Primary Contact, the entire 2.1 miles of this segment are assessed as non-support due to pathogens, possibly originating from illicit sewer connections and failing infrastructure.
Secondary Contact		The entire 2.1 miles of this segment are assessed as non-support due to pathogens, possibly originating from illicit sewer connections and failing infrastructure.
Aesthetics		The entire 2.1 miles of this segment is assessed as non-support due heavy deposits of silt and sand, turbidity, and odors.

RECOMMENDATIONS: South Meadow Brook (Segment MA72-24)

- Attempt to reduce NPS inputs in the form of trash and sediment to this stream system. Reduce instream debris originating from a tile manufacturer near Needham Street.

- Identify sources of elevated fecal coliform bacteria, most notably dry weather storm drain discharges resulting from illicit sewer connections and/or failing infrastructure.

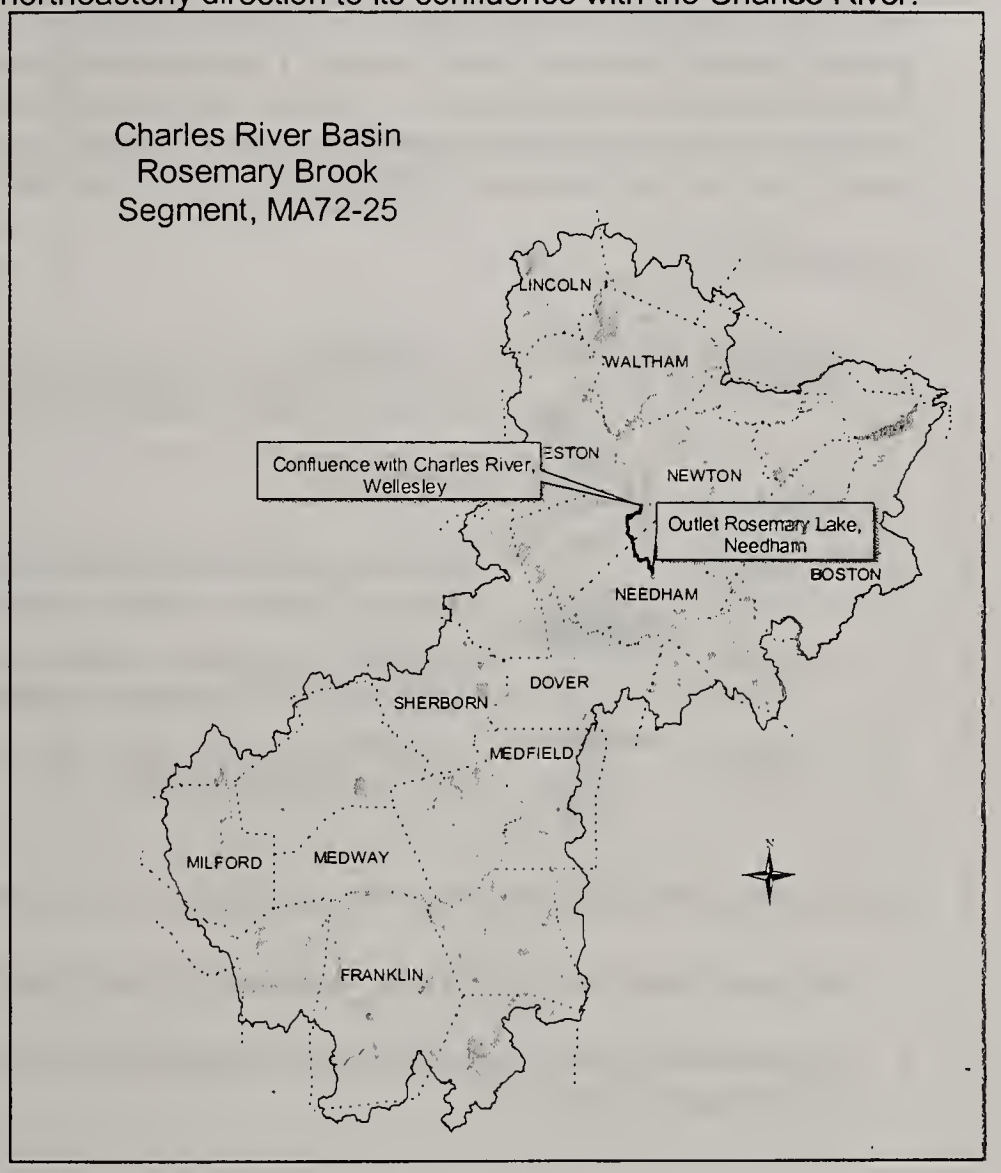
- Stream cleanups should be conducted and dry weather storm drain discharges should be located particularly between Needham Street and Winchester Street.

ROSEMARY BROOK (SEGMENT MA72-25)

Location: Outlet of Rosemary Lake, Needham to confluence with Charles River, Wellesley.
Segment Length: 3.2 miles. Classification: Class B.

SEGMENT DESCRIPTION

Rosemary Brook flows in a generally north/northeasterly direction to its confluence with the Charles River. This tributary drains an area of medium to high-density residential land use, with some light commercial land use in Wellesley and Needham.



WITHDRAWALS AND DISCHARGES

WMA:

1. Four groundwater wells: 3317000-02G, 3317000-04G, 3317000-05G, and 3317000-06G and are located adjacent to Rosemary Brook in Wellesley. Two of the wells in Wellesley (3317000-01G and 3317000-07G) are currently inactive.

USE ASSESSMENT

Stream discharge measurements in Rosemary Brook between June 1997 and April 1998 ranged between 0.23 (estimated) and 12.6 cfs (Appendix B, Table B2).

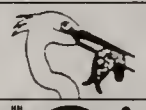
Bacteria sampling was conducted in the Rosemary Brook subwatershed as part of the IM3 Project on three dates, 24 September, 13 and 21 November 1996 (CRWA 1997a). Because of elevated levels of bacteria in the upper watershed, additional sampling was undertaken by CRWA in July and by the Wellesley DPW in August 1997 (CRWA 1998). DWM sampled Rosemary Brook downstream of Barton Road (near its mouth) in Wellesley on eight occasions between July 1997 and April 1998. Fecal coliform data ranged from <20 to 200 cfu/100ml (Appendix B, Table B5). The elevated bacteria densities documented during the IM3 Project appeared to be related to the pond environments and the waterfowl populations that inhabit them although other unknown sources may also exist. Negative results from optical brightener screening in Rosemary Brook at Barton Road suggests that bacteria inputs may be contributed most from nonhuman sources (Appendix B, Table B6). Primary and secondary contact recreational uses are assessed as non-support for the entire 3.2 miles of this segment.

DWM conducted macroinvertebrate and fish biomonitoring during July 1997 in a reach (station RB01) downstream from Barton Road in Wellesley (Appendix C). While instream habitat in the sampling reach offered only marginal fish cover, macroinvertebrate habitat was considered excellent due to well-developed riffle areas and a variety of epifaunal substrates. The macroinvertebrate community sampled received a total metric score of 12, which was only 30% comparable to the reference community indicating moderate impairment. Low overall taxa richness and a reduced EPT index, coupled with a fairly high biotic index, suggests a benthic assemblage stressed by low levels of dissolved oxygen and organic enrichment. Fish community diversity was lower than expected, resulting in the capture of only three species of fish—one of which is not normally associated with lotic systems (*Micropterus salmoides*), and one which displays some tolerance of reduced oxygen (*Catostomis commersoni*). Indeed, DO measurements at RB01 were as low as

3.9 mg/L (42% saturation) (Appendix B, Table B3). Elevated levels of nutrients, particularly phosphorus (0.12 mg/L) and ammonia-nitrogen (0.07) also indicate upstream sources of pollution that may contribute to enriched conditions instream (Appendix B, Table B4). Moderate turbidity, probably caused by the heavy sediment loads often associated with eutrophic conditions, was observed at the RB01 station as well (Fiorentino 1998). The aquatic life use is assessed as non-support for the entire 3.2 miles of Rosemary Brook based on impaired water quality (low dissolved oxygen, organic enrichment) and biological integrity.

The aesthetics use is compromised throughout the segment. Moderate turbidity was observed at the DWM sampling station, while IM3 data revealed TSS levels as high as 150 mg/L in the upper portion of the Rosemary Brook Subwatershed. In addition, sewage odors were observed near Barton Road and waterfowl feathers on some upstream impoundments were visually unappealing. The entire 3.2 miles of Rosemary Brook, therefore are assessed as non-support for the aesthetics use.

SUMMARY

Designated Uses		Status
Aquatic Life		The entire 3.2 miles of this segment are assessed as non-support for the aquatic life use based on degraded water quality (organic enrichment/low DO, elevated nutrients) and biological integrity.
Fish Consumption		Not assessed
Primary Contact		The entire 3.2 miles of this segment are assessed as non-support for the primary contact recreational use due to pathogens, probably originating from waterfowl and unknown sources
Secondary Contact		The entire 3.2 miles of this segment are assessed as non-support for the secondary contact recreational use due to pathogens, probably originating from waterfowl and unknown sources.
Aesthetics		The entire 3.2 miles of this segment are assessed as non-support for the aesthetics use due to turbidity and elevated suspended solids.

RECOMMENDATIONS: Rosemary Brook (Segment MA72-25)

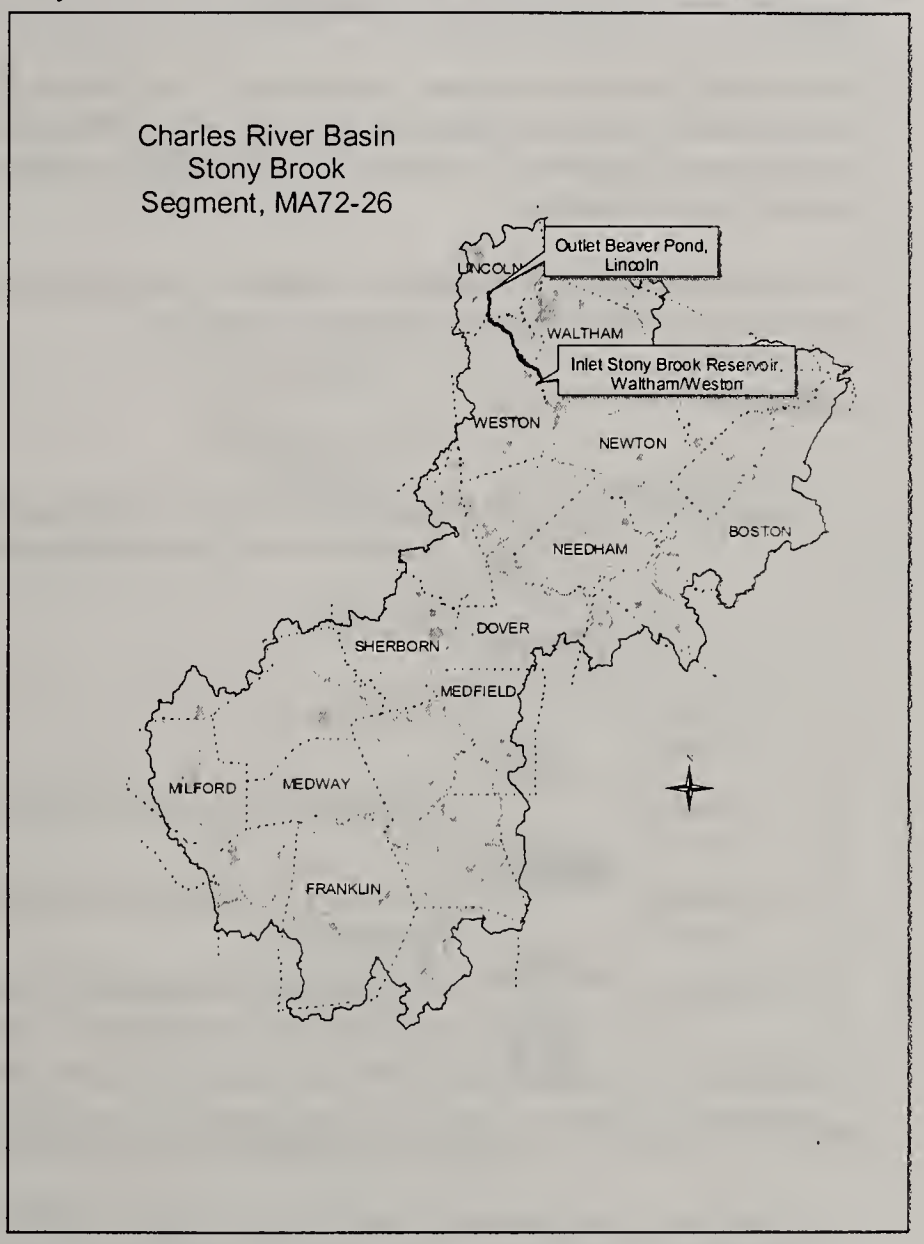
- Additional fecal coliform bacteria sampling to further isolate sources.
- Identify sources of nutrient loadings to Rosemary Brook and implement necessary control strategies to reduce these loadings.

STONY BROOK (SEGMENT MA72-26)

Location: Headwaters, outlet Beaver Pond, Lincoln to inlet of Stony Brook Reservoir, Waltham/Weston
Segment Length: 4.7 miles. Classification: Class A, Public Water Supply.

SEGMENT DESCRIPTION

Stony Brook flows in a generally south-southeasterly direction from the outlet of Beaver Pond in Lincoln to the inlet of Stony Brook Reservoir in Waltham/Weston. The stream drains an area of mostly light residential land use and open space, receiving the discharges of three major tributaries—Iron Mine Brook, Cherry Brook, and Hobbs Brook. Stony Brook is the second largest tributary in the Charles River Watershed. The City of Cambridge obtains most of its water supply form the Hobbs Brook and the Stony Brook Reservoirs. Management of these impoundments effectively controls the entire subwatershed.



WITHDRAWALS AND DISCHARGES
WMA:

1. Three community groundwater withdrawals: 3157000-01G in Lincoln; 3333000-01G in Weston; and 3049000-03S in Cambridge.

NPDES:
To Stony Brook:

1. MA000041 Exxon Oil Waltham terminal
2. MA0020222 Mobil Oil Corporation, Weston
3. MA0035343 Massachusetts Broken Stone Company, Weston

To Stony Brook Subwatershed:

1. MA0031917596 Old Boston Post Road
2. MA0033774 United States Postal Service
3. MA0028495 Bay Colony Corporate Center
4. MA0031089 Tecogen Division of Thermal Power

USE ASSESSMENT

Stream discharge measurements in Stony Brook were collected between June 1997 and November 1997. The discharge ranged between 0.31 and 7.75 cfs (Appendix B, Table B2).

Water quality monitoring was conducted in Stony Brook by DWM at Church Street, Weston (station ST01) on five occasions between 17 June and 4 November 1997. Fecal coliform bacteria densities ranged from 40 to 480 cfu/100ml (Appendix B, Table B5). Since the only high bacteria count was in November (outside of the primary contact recreational use season), both the primary and secondary recreational uses are assessed as support.

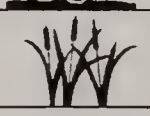
Macroinvertebrate and fish biomonitoring was conducted in Stony Brook (station ST01) approximately 50m downstream from Church Street (Appendix C). ST01 was designated as the regional reference station for the Charles River Watershed biomonitoring survey by virtue of its high habitat evaluation, minimal upstream/adjacent land use impacts (e.g. absence of point source inputs, lack of channelization and nearby

agricultural activity, minimal development, undisturbed and well-vegetated riparian zone), and excellent water quality (as determined from previously conducted monthly water quality sampling). Benthos data revealed an assemblage indicative of the "best attainable conditions" in the watershed (Appendix C). The macroinvertebrate community was characterized by a diverse and well-balanced assemblage of pollution-sensitive taxa, and was especially rich in clean water forms of EPT taxa. Fish community sampling yielded three taxa, Eastern Brook Trout (*Salvelinus fontinalis*), Brown Trout (*Salmo trutta*), and Redfin Pickerel (*Esox americanus americanus*)--all pollution-intolerant forms. The aquatic life use in Stony Brook is assessed as support based on the biological evaluation.

As expected, dissolved oxygen levels were good (station ST01), although values were not representative of "worse case" conditions (Appendix B, Table B3). With the exception of one slightly elevated phosphorus measurement (0.08 mg/L), all other water quality parameters indicates very high water quality conditions (Appendix B, Table B4).

The aesthetics use for the entire 4.7 miles of this segment is assessed as support based on clarity of water column and minimal instream aquatic vegetation.

SUMMARY

Designated Uses		Status
Aquatic Life		The entire 4.7 miles of this segment are assessed as support for the aquatic life use based on good water quality and overall excellent biological integrity.
Fish Consumption		Not assessed
Drinking Water		Not assessed
Primary Contact		The entire 4.7 miles of this segment are assessed as support for the primary contact recreational use.
Secondary Contact		The entire 4.7 miles of this segment are assessed as support for the secondary contact recreational use.
Aesthetics		The aesthetics use for the entire 4.7 miles of this segment is assessed as support for the aesthetics use based on clarity of water column and minimal instream aquatic vegetation.

RECOMMENDATIONS: Unnamed Tributary (Segment MA72-26)

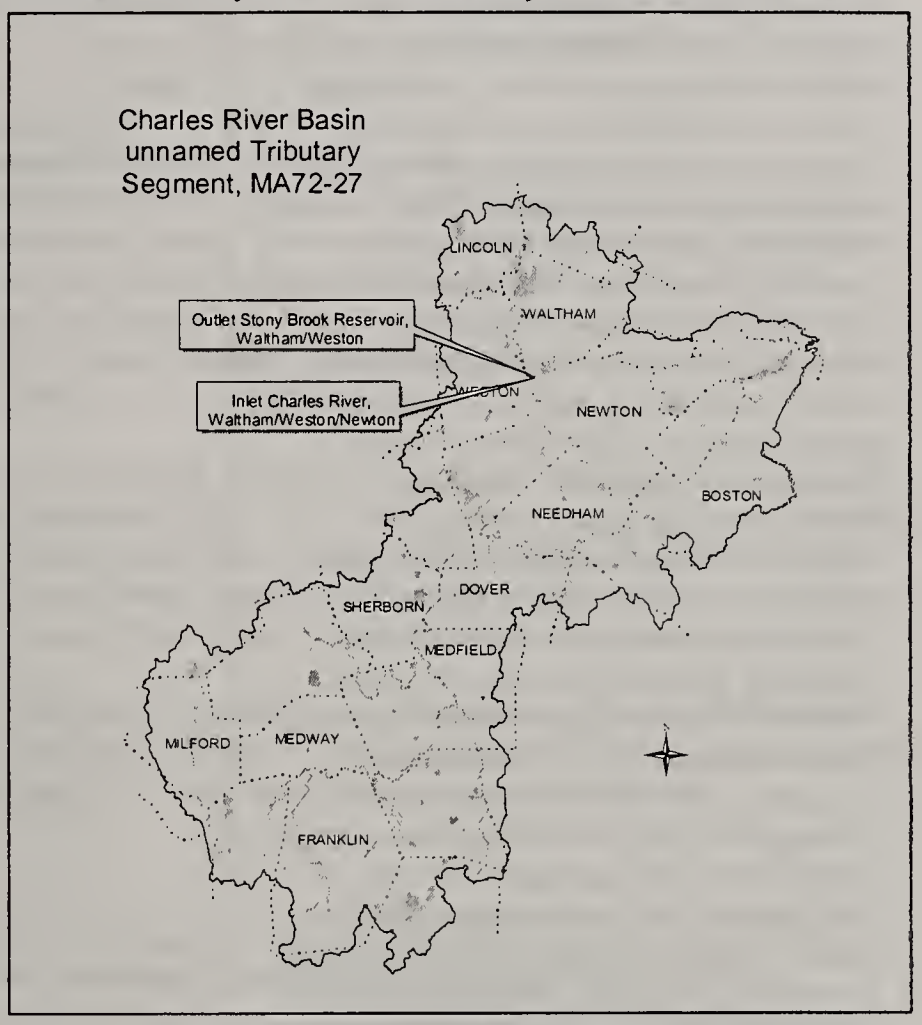
- Continue to monitor water quality and biological health in this stream system, as it affords the "best attainable " conditions in the entire Charles River Watershed in terms of habitat quality, water quality, and biological integrity.

UNNAMED TRIBUTARY (SEGMENT MA72-27)

Location: Outlet, Stony Brook Reservoir, Waltham/Weston to confluence with the Charles River, Waltham/Weston/Newton. Segment Length: 0.2 miles. Classification: Class B.

SEGMENT DESCRIPTION

From the outlet of Stony Brook Reservoir, this unnamed tributary flows in an easterly direction for 0.2 miles before joining the mainstem Charles River in the Lakes District. Land use is predominately open space and forest along the Weston side (south), and open space with some commercial land use along the Waltham (north) side of the stream.



WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0033031 Weston Sanitary Landfill receiving subwatershed unknown.

USE ASSESSMENT

Water quality monitoring was conducted in this segment (station ST00) by DWM downstream from South Street, Waltham/Weston on three occasions from 9 December 1997 and 22 April 1998. Fecal coliform bacteria levels were always less than 20 cfu/100ml, therefore the primary and secondary recreational life uses are assessed as support for the entire 0.2 miles (Appendix B, Table B5).

All other water quality variables were similar to conditions upstream from Stony Brook Reservoir at Church Street (Segment MA72-26), and indicated high water quality (Appendix B, Tables B3 and B4). Therefore, the aquatic life and aesthetics uses are supported for the entire 0.2 miles of this segment.

SUMMARY

Designated Uses		Status
Aquatic Life		The entire 0.2 miles of this segment are assessed as support based on good water quality.
Fish Consumption		Not assessed
Primary Contact		The entire 0.2 miles of this segment are assessed as support.
Secondary Contact		The entire 0.2 miles of this segment are assessed as support.
Aesthetics		The aesthetics use for the entire 0.2 miles of this segment are assessed as support.

RECOMMENDATIONS: Stony Brook (Segment MA72-27)

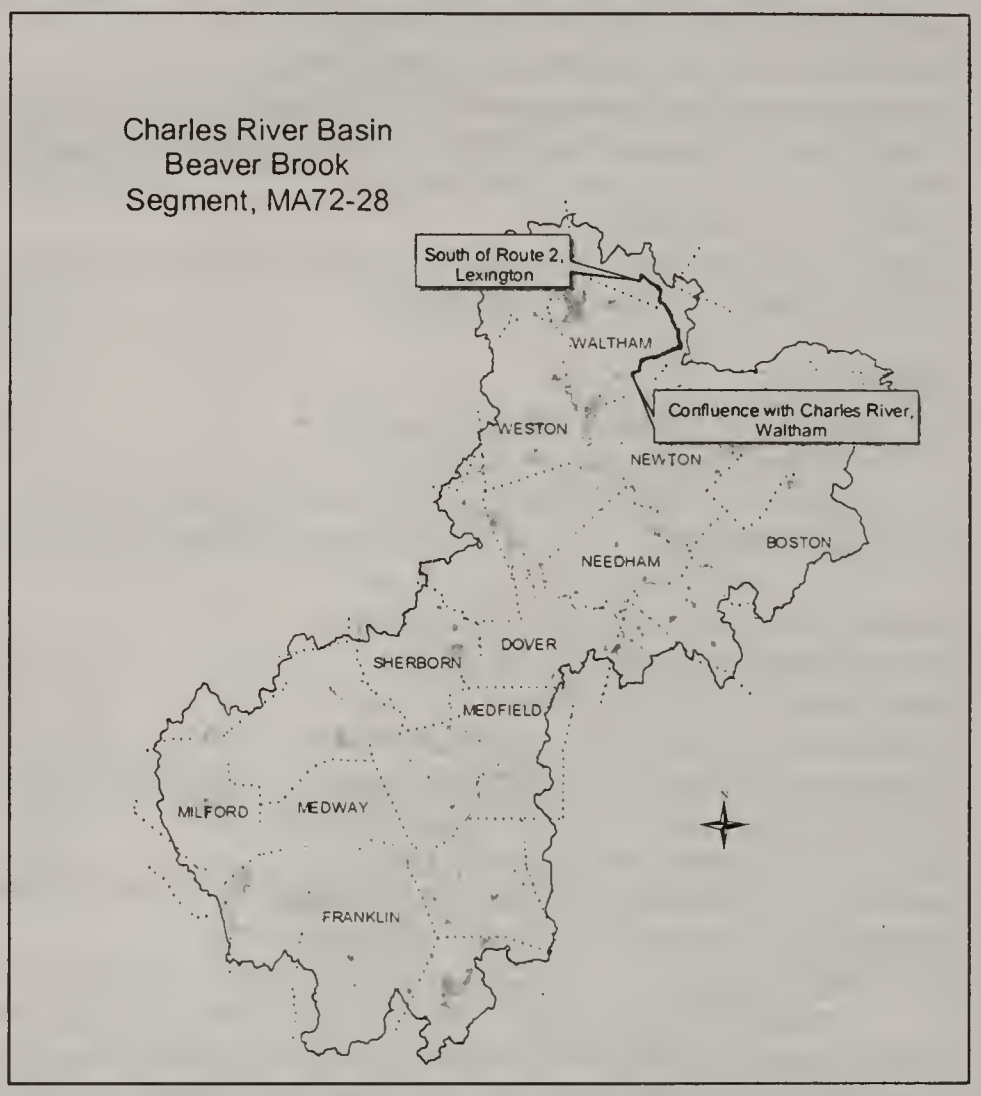
- Continue to monitor water quality in this stream system, as it offers excellent overall water quality and instream habitat quality, despite the urbanized nature of surrounding land use.

BEAVER BROOK (SEGMENT MA72-28)

Location: Headwaters south of Route 2, Lexington to Charles River, Waltham. Segment Length: 8.0 miles. Classification: Class B.

SEGMENT DESCRIPTION

From its headwaters just south of Route 2 in Lexington, Beaver Brook flows in a northerly direction. After crossing Route 2 it continues to flow north for a short distance before heading south and crossing Route 2 once again. The stream continues in a southerly direction for several miles, draining an area of mostly open space, a golf course, vast wetlands, and light to moderate residential land use. After flowing through the MDC-owned Beaver Brook Reservation (which includes Mill Pond and Duck Pond) in Belmont, Beaver Brook crosses under Route 60 and through the remainder of the reservation before entering an area of heavy residential, commercial and industrial land use. Here the stream heads in a southwesterly direction into Waltham, receiving the drainage area of Lyman Pond and Chester Brook near Route 60 before being culverted underground. Beaver Brook does not emerge from underground until it reaches River Street in Waltham, just upstream from its confluence with the mainstem Charles River. This final portion of the watershed is heavily urbanized, with predominantly residential and commercial land uses.



WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0027821 W. R. Grace & Company
2. MA0004880, MA0036447 Waverly Oaks Park Shell Oil Company.

USE ASSESSMENT

All biological and water quality monitoring in Beaver Brook was confined to the portion of the segment downstream from the Beaver Brook Reservation impoundments, therefore all uses upstream from Mill Pond are not assessed.

Stream discharge measurements in Beaver Brook (two stations) were collected between July 1997 and April 1998. Collectively the discharges of the two stations ranged from 0.32 to 22.0 cfs (Appendix B, Table B2).

Water quality monitoring was conducted in Beaver Brook (station BE01) by DWM near Route 60 in Waltham on three occasions between 1 July 1997 and 20 August 1997. It was then sampled further downstream near its confluence with the Charles River (station BE00) on five occasions between 7 October 1997 and 22 April 1998 when accessibility improved. Fecal coliform bacteria levels ranged from 480-4400 cfu/100ml, thereby impairing both the primary and secondary recreational uses (Appendix B, Table B5). The lower 3.0 miles of the segment are assessed as non-support for these uses due to elevated pathogens, which probably originate from both dry and wet weather stormdrain discharges. Consistently positive results from optical

brightener screening at several stations indicate that elevated fecal coliform levels are human in origin, and probably enter Beaver Brook via illicit sewer connections to the storm drain system (Appendix B, Table B6). Considerable dry weather discharge was often observed from a pipe located under the Route 60 road crossing just upstream from Lyman Pond and DWM's sampling station (Fiorentino 1998). Other water quality parameters also indicated severely degraded water quality at both DWM sampling stations. Elevated nutrient levels, as high as 0.68 mg/L for ammonia-nitrogen and 0.16 for phosphorus, probably are a result of upstream dry weather stormdrain discharge(s) (Appendix B, Table B4). Dissolved oxygen levels were particularly low (2.0 mg/L at 22 % saturation) at the upstream station, while measurements ranged from 6.2-12.3 mg/L near the mouth (Appendix B, Table B3). None of the DO data represented worst case conditions, but is clearly indicative of degraded conditions in this portion of the stream.

Because habitat constraints made biomonitoring impractical at the DWM water quality stations, macroinvertebrate sampling was conducted further upstream in Beaver Brook Reservation (station BE02) near Trapelo Road (Appendix C). Moderate impairment of the benthos appears to be primarily the result of habitat alterations—particularly flow regulation in the Beaver Brook Reservation. Site visits to the BE02 biomonitoring station a few months following sampling found the stream bed completely dry from the outlet of Duck Pond to its lower reaches in the reservation—exposing what would have been superb macroinvertebrate and fish habitat (Fiorentino 1998).

Based on degraded water quality resulting from urban runoff downstream from Beaver Brook Reservation, and a moderately impaired macroinvertebrate community in the vicinity of the reservation, the lower 3.0 miles of this segment are assessed as non-support due to organic enrichment/low DO, nutrients, siltation, and turbidity. In addition, habitat modifications and the apparent regulation of flow by MDC appear to be primary causes of impairment to aquatic life use in the Beaver Brook Reservation portion of this segment.

The aesthetic use is particularly impaired in the portion of Beaver Brook downstream from the Metropolitan District Commission reservation, primarily as a result of siltation, turbidity, and objectionable odors associated with urban runoff. The lower 3.0 miles of this segment are assessed as non-support for this use.

SUMMARY

Designated Uses		Status
Aquatic Life		The upper 5.0 miles are not assessed. The lower 3.0 miles of this segment do not support this use based on organic enrichment/low DO, nutrients, habitat modification, and unknown.
Fish Consumption		Not assessed
Primary Contact		The upper 5.0 miles are not assessed. The lower 3.0 miles of this segment are assessed as non-support due to pathogens associated with urban runoff.
Secondary Contact		The upper 5.0 miles are not assessed. The lower 3.0 miles of this segment are assessed as non-support due to pathogens associated with urban runoff.
Aesthetics		The upper 5.0 miles are not assessed. The lower 3.0 miles of this segment are assessed as non-support based on turbidity, odors, and siltation associated with urban runoff.

RECOMMENDATIONS: Beaver Brook (Segment MA72-28)

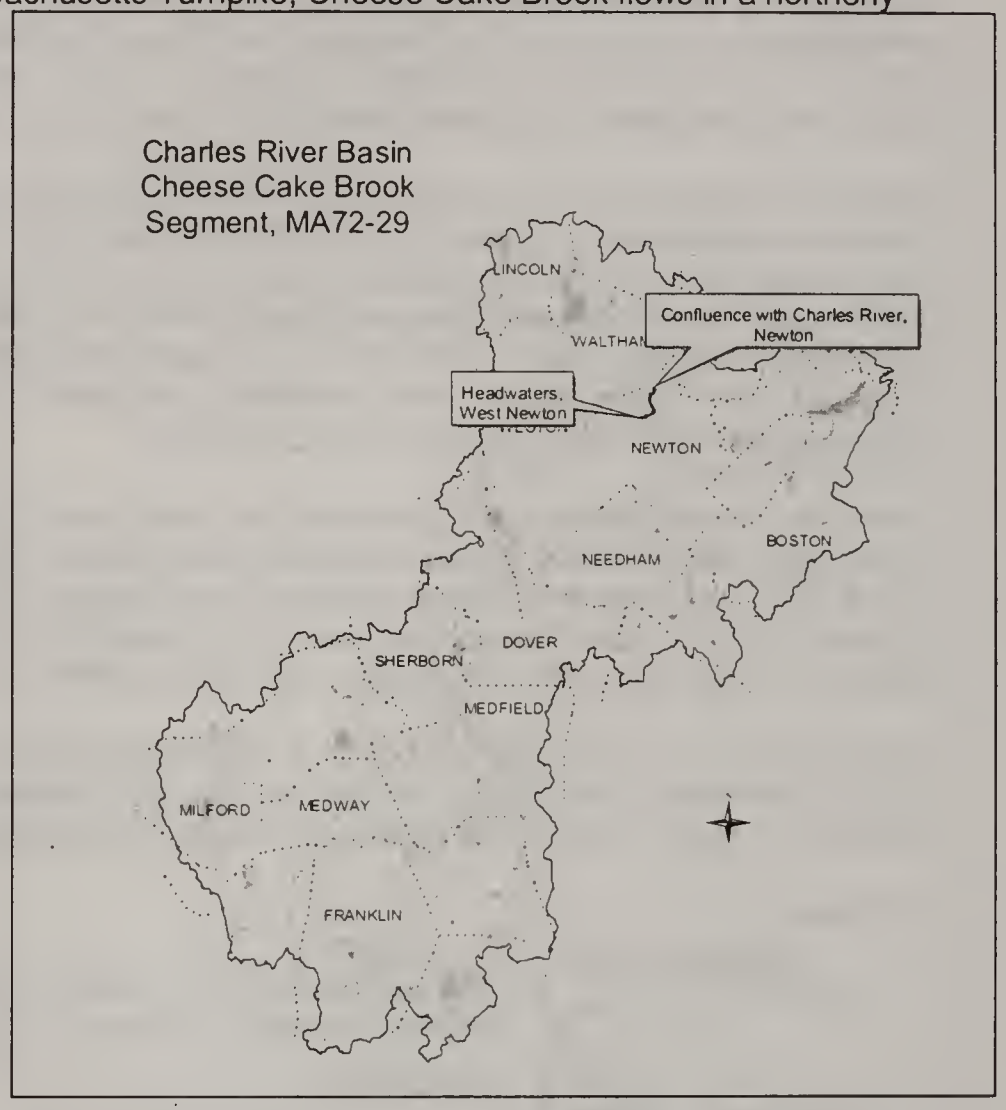
- Recommend MDC (Metropolitan District Commission) maintain instream baseflows downstream from Beaver Brook Reservation impoundments (i.e., Mill Pond/Duck Pond). This portion of the stream could offer superb macroinvertebrate habitat if water quantity was not compromised.
- Locate/isolate sources of elevated fecal coliform bacteria inputs to Beaver Brook, making necessary infrastructures upgrades to eliminate illicit sewer connections and dry weather storm drain discharges to the stream.
- Identify areas of riparian zone degradation. Implement BMPs to restore/improve riparian habitat throughout lower portion of Beaver Brook Reservation.

CHEESE CAKE BROOK (SEGMENT MA72-29)

Location: Headwaters just south of the Massachusetts Turnpike in West Newton to the confluence with the Charles River in Newton/Waltham. Segment Length: 1.4 miles. Classification: Class B.

SEGMENT DESCRIPTION

From its headwaters just south of the Massachusetts Turnpike, Cheese Cake Brook flows in a northerly direction until it crossing Route 30. This first portion is entirely underground, draining a heavily urbanized portion of the watershed. After appearing for the first time at the Route 16 culvert in West Newton, it turns to a northeasterly direction along Route 16 before bearing north near the Horace Mann School in Newton. Completely channelized, it continues to flow in a northerly direction through an area of heavy residential and recreational land use before reaching the mainstem Charles River.



WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0033472 Radiant Fuels, Newton
2. MA0033685 Mobil Oil Corporation, Newton

USE ASSESSMENT

Stream discharge measurements in Cheese Cake Brook were collected between June 1997 and April 1998. The stream discharge measurements ranged between 0.34 (estimated) and 4.68 cfs (Appendix B, Table B2).

Water quality monitoring was conducted near the mouth or Cheese Cake Brook (station CB01) by DWM from 1 June 1997 to 22 April 1998 on nine occasions. Fecal coliform bacteria levels ranged between 340 and 4,000 cfu/100ml at the mouth of Cheese Cake Brook (Appendix B, Table B5). One stormdrain pipe (near Watertown Street, station CBE1) sampled upstream from the sampling station had a count of 50,000 cfu/100ml. Positive results from optical brightener screening at several stations in Cheese Cake Brook indicate that human sources contribute to elevated fecal coliform levels, most likely via several dry weather discharges along this segment. Strong optical brightener readings were documented just downstream from the Watertown Street stormdrain outfall, where fecal coliform counts were also high (Appendix B, Table B6). Cheese Cake Brook does not support either the primary or secondary contact recreational use.

Instream dissolved oxygen concentrations were above 5.0 mg/L, although these data were not collected under worse-case conditions. Saturation was as low as 55% on one occasion, while supersaturated (133%) conditions occurred on another occasion (Appendix B, Table B3). Occasional elevated nutrient levels (as high as 0.23 mg/L for ammonia-nitrogen and 0.11 for phosphorus) were measured (Appendix B, Table B4). Chlorides and conductivity measurements were generally high throughout the survey period.

Complete channelization, the reduction/elimination of the riparian zone, and massive amounts of sedimentation also impairs this stream's ability to support a healthy biological community. Macroinvertebrate monitoring (although qualitative due to habitat constraints) yielded only two taxa, Hydropsychidae and

Chironomidae, corroborating the habitat and water quality degradation observed throughout the stream (Appendix C). This stream does not support the aquatic life use.

The aesthetic use is impaired throughout Cheese Cake Brook primarily a result of sediment deposition, dense aquatic vegetation, sewage odors, visual observation of oil slicks; particularly associated with urban runoff (Appendix C).

SUMMARY

Designated Uses		Status
Aquatic Life		This segment does not support this use based on organic enrichment/low DO, nutrients, habitat modification, and other unknowns.
Fish Consumption		Not assessed
Primary Contact		The 1.4 miles of this segment do not support this use due to pathogens associated with urban runoff.
Secondary Contact		The 1.4 miles of this segment do not support this use due to pathogens associated with urban runoff.
Aesthetics		The 1.4 miles of this segment are assessed as non-support based on odors, oil slicks, sedimentation, and density of nuisance aquatic vegetation associated with urban runoff.

RECOMMENDATIONS: Cheese Cake Brook (Segment MA72-29)

- Restore/improve vegetative buffer along both sides of the stream.

- Locate/isolate sources of elevated fecal coliform bacteria inputs to the stream, making necessary infrastructures upgrades to eliminate illicit sewer connections and dry weather storm drain discharges to the stream. Of particular concern is the storm drain outfall located just upstream from Watertown Street, although several other discharges may exist upstream from Eddy Street throughout the underground portion of this stream.

- Identify sites and implement BMPs throughout Cheese Cake Brook to prevent road runoff and sediment inputs particularly along Albemarle Road.

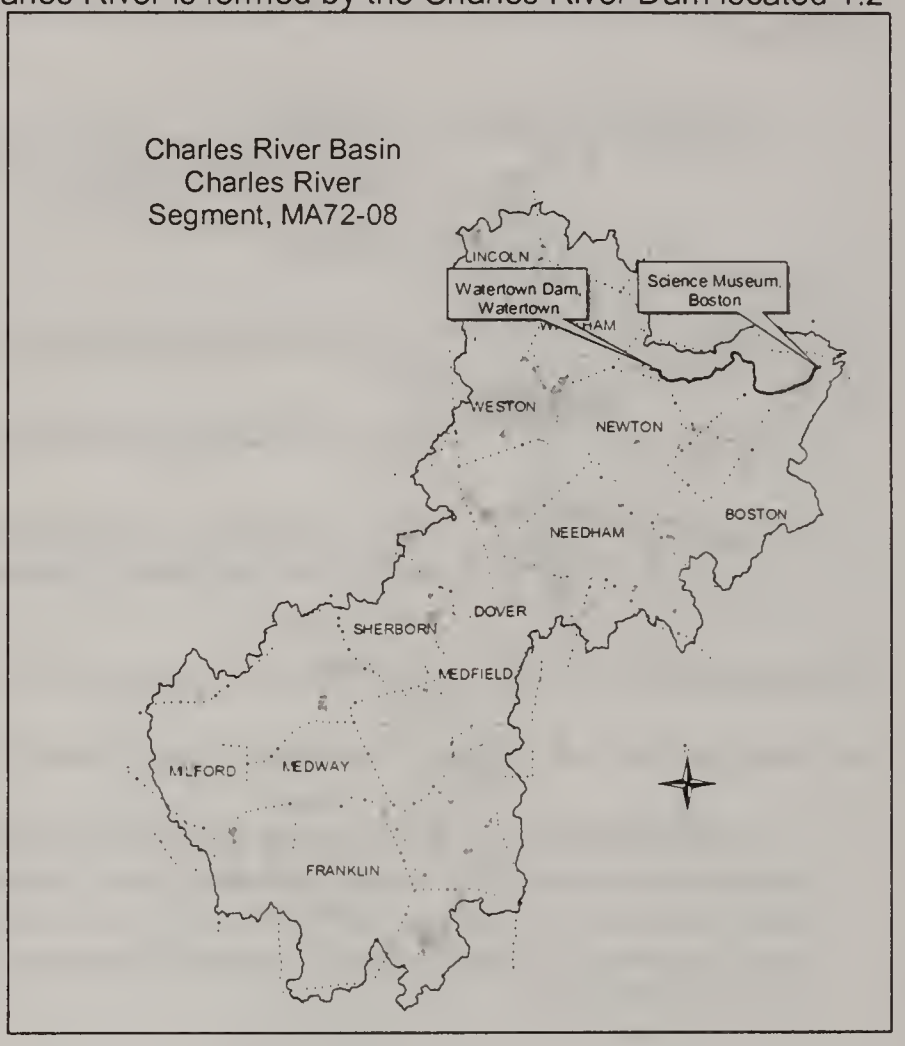
- Encourage residents to properly dispose of pet feces, especially in the vicinity of Albemarle Road where there is a minimal riparian buffer to NPS inputs (Appendix C).

CHARLES RIVER (SEGMENT MA72-08)

Location: Watertown Dam, Watertown to Science Museum Dam, Boston. Segment Length: 8.6 miles.
Classification: Class B, Warm Water Fishery.

SEGMENT DESCRIPTION

The lake-like nature of this segment of the Charles River is formed by the Charles River Dam located 1.2 miles above the mouth of the river. From the Watertown Dam in Watertown, the river meanders in a generally easterly direction prior to reaching the Science Museum Dam at the Boston/Cambridge border. This reach of the Charles River is referred to as "the Basin". After flowing around this dam the Charles River flows to the canal locks at the Charles River Dam. This entire portion of the watershed is extremely urbanized, with a multitude of commercial, residential, industrial, and recreational land uses along both sides of the river. This segment of the Charles River also receives the discharges of numerous Combined Sewer Overflows (CSO's) which historically and presently contribute extremely elevated fecal coliform levels during periods of heavy rain. The drainage area of the Muddy River, which originates in Jamaica Pond and joins the mainstem Charles River just upstream from the Harvard Bridge, also has historically contributed to impaired water quality due to and urban runoff.



WITHDRAWALS AND DISCHARGES

There are 19 existing permitted CSO discharges to the Basin. Of these discharges, five are permitted to the City of Cambridge, five to the Boston Water & Sewer Commission, one to the City of Somerville, and eight to the Massachusetts Water Resources Authority (MWRA). All of the discharges are untreated with the exception of discharges from the Cottage Farm CSO treatment facility.

There are also numerous major and minor NPDES discharges and Combined Sewer Overflows along both the mainstem Charles River and the Muddy Brook watershed.

CSO and Stormwater Management

The Massachusetts Water Resources Authority on 31 July 1997 issued its final CSO Facilities Plan/Environmental Impact Report (Metcalf & Eddy Consulting Engineers 1997). The report represents the culmination of years of technical assessment work to identify appropriate CSO control alternatives throughout the CSO planning area. In the Basin, the recommended plan includes: Sewer Separation in the Stony Brook area; upgrades to the Cottage Farm CSO treatment facility to provide more effective disinfection and dechlorination facilities; hydraulic relief at CAM 005; and floatables control at the CSO outfalls to remain active. Six of the nineteen outfalls will close as part of the plan. The remaining outfalls are expected to discharge only once or twice during a year with typical precipitation, with the exception of the Cottage Farm Facility and it is predicted to discharge treated overflows seven times per year on the average.

The recommended level of CSO control was based on an assessment of the CSO and non-CSO pollutant loads to the Basin and the water quality improvements and costs of the range of CSO control alternatives. In the Report, MWRA also suggested that DEP issue a variance for the remaining CSO discharges to the Basin

to allow time for additional information to be gathered on pollutant sources and loads. A final decision on requiring any further CSO control will be deferred until the additional information is gathered and assessed. DEP has agreed with the findings in the Report, and on 1 October 1998, formally issued a variance for the remaining CSO discharges to the Basin (pursuant to 314 CMR 4.03(4))[1]. The *Variance* is a short-term (24-36 month) modification in the water quality standards, within the context of the NPDES/MA permit program. MWRA and others will continue to conduct analyses to determine the potential for additional water quality improvements from higher levels of CSO treatment, reductions in the number of overflows (through CSO storage), and/or remediation of stormwater discharges. The standard for the segment of the Charles River from the Watertown Dam to Science Park is modified ONLY for the CSO discharges, and all other discharges must meet the Class B standards.

The *Variance* requires MWRA to conduct additional analyses on CSO and stormwater loads and their water quality impacts. MWRA is complying with the *Variance* by providing funding and participating in the USGS study entitled *Stormwater and Mainstream Loads of Bacteria, Nutrients, and Selected Metals, Lower Charles River Watershed, Massachusetts* (Appendix D). This study will help define the stormwater and upstream loads, as well as potential mitigation of stormwater loads by implementation of various stormwater controls. DEP will review the findings of the USGS study and all other ongoing water quality monitoring and assessment work (Appendix D) in making a determination on the final CSO control requirement, and in developing stormwater management strategies for implementation in the watershed.

EPA and DEP have also been working together to address stormwater pollution sources in the ten communities in the Lower Basin, where stormwater impacts appear to be the most significant. As part of their Clean Charles 2005 Initiative (to make the Charles meet fishable/swimmable standards by Earth Day 2005), EPA has required, using enforcement orders where necessary, these communities to identify and eliminate all illegal wastewater discharges to separate stormdrain systems. The work has resulted in the elimination of tens of thousands of gallons of raw wastewater discharges per day through illegal connections to the stormdrain systems. Measurable water quality improvements have been noted during dry weather water quality monitoring as a result of the extensive illegal connection removal programs.

The lower ten communities are also now in the process of developing and implementing "state-of-the art" stormwater management plans to mitigate wet weather pollution from their storm drain system. DEP has worked with EPA in reviewing the technical reports and plans submitted by the communities, and DEP is also providing State Revolving Fund (SRF) financial assistance to Cambridge, Newton, Needham, and Dedham for illegal connection removal and stormwater management planning projects.

USE ASSESSMENT

Among the findings in the MWRA CSO Facilities Plan was that stormwater loads are the predominant source of pollutants in the Basin (Metcalf & Eddy Consulting Engineers 1997). Water quality monitoring by MWRA and the CRWA supported this finding

The EPA, as part of their Charles River Water Quality Study recorded continuous DO, temperature, and pH readings at two sites downstream from the Watertown Dam in Cambridge (Harvard Boat Club dock and MIT boathouse dock) 13 August 1997 to 15 August 1997 (EPA 1998). The DO readings at these stations were all above 6.23 mg/L.

MWRA has been monitoring the Charles River Watershed since 1989. During the 1998 focus on the Charles River, water quality and CSO receiving water monitoring was conducted. Water quality data were collected at two stations (Watertown Dam and Sciences Museum Dam) weekly, year round, emphasizing eutrophication. The DO concentrations were similar to previous years with all readings at or above 5 mg/L in both the surface and bottom waters, at both stations. CSO receiving waters were monitored at 14 station three days per week, every five weeks, year round. This monitoring effort focused on bacteria, hydrographic data and relationship to rain fall. Fecal coliforms remained near or above the primary contact recreational use standard at all sampling locations; however several samples at the Science Museum site dropped to near 0 cfu/100mls for the first time in over nine months (Rex 1999).

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[1] The DEP Guidance for Abatement of Pollution from CSO Discharges (dated August 11, 1997) describes the regulatory classifications for CSO-impacted receiving waters and the regulatory requirements for long-term CSO control planning.

Elevated fecal coliform bacteria counts were documented by the IM3 Project at their seven monitoring stations in this segment of the Charles River (resulting from urban runoff, storm drains, CSO discharges, etc). Between October 1995 and December 1997 fecal coliform counts ranged from <10 – 16,900 cfu/100ml during baseline conditions and from <10 – 59,000 cfu/100ml during wet weather conditions (CRWA 1997 and CRWA 1998). Primary and secondary contact recreational uses are not supported in this segment of the Charles River.

Sediment quality monitoring was conducted in this segment at two stations, as part of the IM3 project (EPA work) and at 35 stations as part of the Watertown Arsenal site investigation. Acute toxicity to the amphipod, *Hyalella azteca*, and the midge, *Chironomus tentans*, was documented at the two stations tested by EPA (IM3 project). Sediment contamination in the form of acute toxicity, heavy metals, polyaromatic hydrocarbons (PAHs), and organics exist in this segment of the Charles River (CWRA 1998).

DWM conducted macroinvertebrate biomonitoring in a wadeable reach immediately downstream from the Watertown Dam (station CR00). The dominance of filter-feeders and pollution tolerant forms, and lack of EPT taxa indicates this community is structured in response to organic enrichment and associated elevated levels of FPOM. Indeed, heavy deposits of particulate matter were observed on instream substrates, and a thriving algal community throughout the sampling reach reflects the effects of enrichment (Appendix C). Dissolved oxygen levels, while not representing worst-case conditions, appear normal (Appendix B, Table B3). However, the elevated levels of phosphorus at the DWM sampling station coupled with the high chlorophyll a concentrations (as high as 48 µg/L at Massachusetts Avenue) measured by CRWA further downstream corroborate the eutrophic nature of this segment (CRWA 1998).

Macroinvertebrate data collected for the closure of the Watertown Arsenal Materials Testing Laboratories (AMTL) by Plexus Scientific Corporation, revealed a severely degraded benthos community in the vicinity of the Watertown Arsenal (1996). The soft substrates and low instream velocities present are typical in this portion of the Charles River. Low diversity and the dominance of extremely pollution-tolerant taxa (most notably, Tubificid worms) were consistently. Based on impairments to the CR00 macroinvertebrate community, as well as benthos degradation near the Watertown AMTL, the entire 8.6 miles of this segment is assessed as non-support for aquatic life use. Causes of impairment are organic enrichment and nutrients, although other unknown sources associated with urban runoff (e.g., stormwater) are probable as well. Although there are no CSO discharges within two miles of the Watertown Dam and AMTL, CSO input poses a threat to biological integrity throughout this portion of the basin.

As a follow up to the 1994 fish toxics monitoring work, additional fish samples were collected in November 1995. In May 1996, DPH extended their advisory from Needham downstream to the Museum of Science Dam in Boston/Cambridge because of persistent elevated levels of PCB in carp (DPH 1998). The fish consumption use is therefore non-support.

The aesthetics use is also non-support for the entire 8.6 miles of this segment. High levels of turbidity, occasional observations of objectionable solids, and sewage-related odors all contribute to impaired aesthetic quality in this segment (Fiorentino 1998). In addition, excessive growth of nuisance aquatic vegetation—particularly from the Watertown Dam to the Eliot Bridge—contributed to this assessment.

SUMMARY

Designated Uses		Status
Aquatic Life		The entire 8.6 miles are non-support for the aquatic life use due to organic enrichment, nutrients, and other unknown sources associated with urban runoff.
Fish Consumption		The entire 8.6 miles does not support the fish consumption use since DPH has issued an advisory against eating carp because of elevated levels of PCB.
Primary Contact		The entire 8.6 miles of this segment are assessed as non-support due to pathogens associated with urban runoff (stormwater, CSOs, and other unknown sources).
Secondary Contact		The entire 8.6 miles of this segment are assessed as non-support due to pathogens associated with urban runoff (stormwater, CSOs, and other unknown sources).
Aesthetics		The entire 8.6 miles of this segment are assessed as non-support due to turbidity, odors, objectionable solids, oils, and nuisance aquatic vegetation.

RECOMMENDATIONS: Charles River (Segment MA72-08)

- Continue to monitor water quality conditions in this segment of the Charles River to assess the effectiveness of proposed and current cleanup projects.

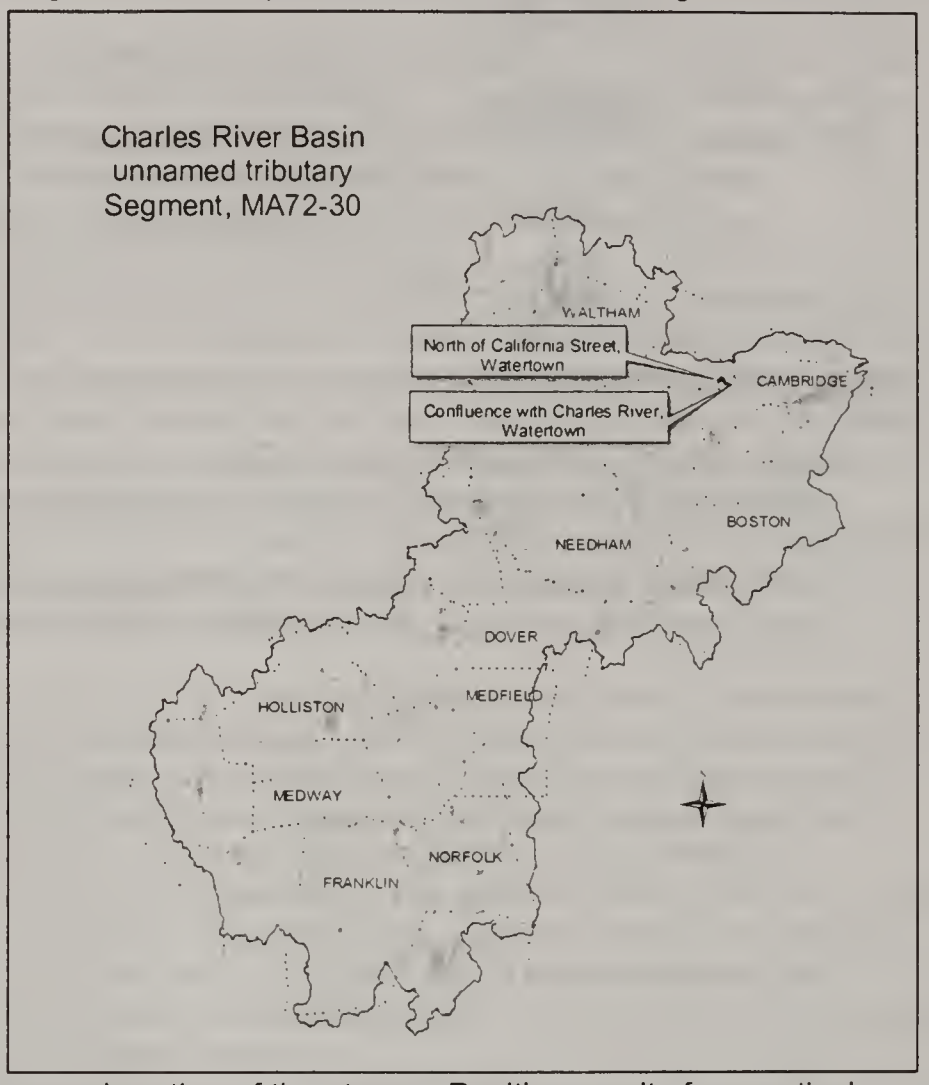
- DEP and EPA should continue to gather information and track progress on the management of stormwater pollutant loads, and to refine stormwater strategies to improve water quality in the Basin.

UNNAMED TRIBUTARY (SEGMENT MA72-30)

Location: Headwaters in Newton to its confluence with the Charles River in Watertown.
Segment Length: Unknown. Classification: Class B.

SEGMENT DESCRIPTION

Locally referred to as "Laundry Brook", this underground tributary of the Charles River emerges from a culvert at California Street in Watertown. It flows in a northerly direction for a mere 15m before joining the mainstem Charles River just downstream from the Watertown Dam. The stream drains an area of heavy residential and commercial land use. The total length of this tributary is unknown.



WITHDRAWALS AND DISCHARGES

None known.

USE ASSESSMENT

Discharge measurements made in Laundry Brook between June 1997 and April 1998. The stream discharge ranged from 0.13 to 4.31 cfs (Appendix B, Table B2).

Water quality monitoring was conducted near the mouth of Laundry Brook (LB01) by DWM from 1 June 1997 to 22 April 22 1998 on nine occasions. Fecal coliform bacteria levels ranged between 20 and 6,000 cfu/100ml (Appendix B, Table B5). This stream does not support either the primary or secondary contact recreational use due to elevated pathogens originating in the under ground portion of the stream. Positive results from optical brightener screening indicate that human sources probably contribute to this problem (Appendix B, Table B6).

Although instream dissolved oxygen concentrations were above 7.6 mg/L, these data were not collected under worse-case conditions (Appendix B, Table B3). Elevated levels of phosphorus (0.10 mg/L on most occasions) were also detected (Appendix B, Table B4). Coupled with the lack of habitat (culverted stream conditions) the aquatic life use is assessed as non-support.

The aesthetic use in the above-ground portion of this segment is not supported, primarily a result of sediment deposition, objectionable odors, and turbidity (Fiorentino 1998).

SUMMARY

Designated Uses		Status
Aquatic Life		The entire segment does not support this use based on elevated nutrients and habitat modification.
Fish Consumption		Not assessed
Primary Contact		The entire segment does not support this use due to pathogens associated with urban runoff.
Secondary Contact		The entire segment does not support this use due to pathogens associated with urban runoff.
Aesthetics		The entire segment does not support the aesthetics use based on odors and turbidity associated with urban runoff.

RECOMMENDATIONS: Unnamed Tributary (Segment MA72-30)

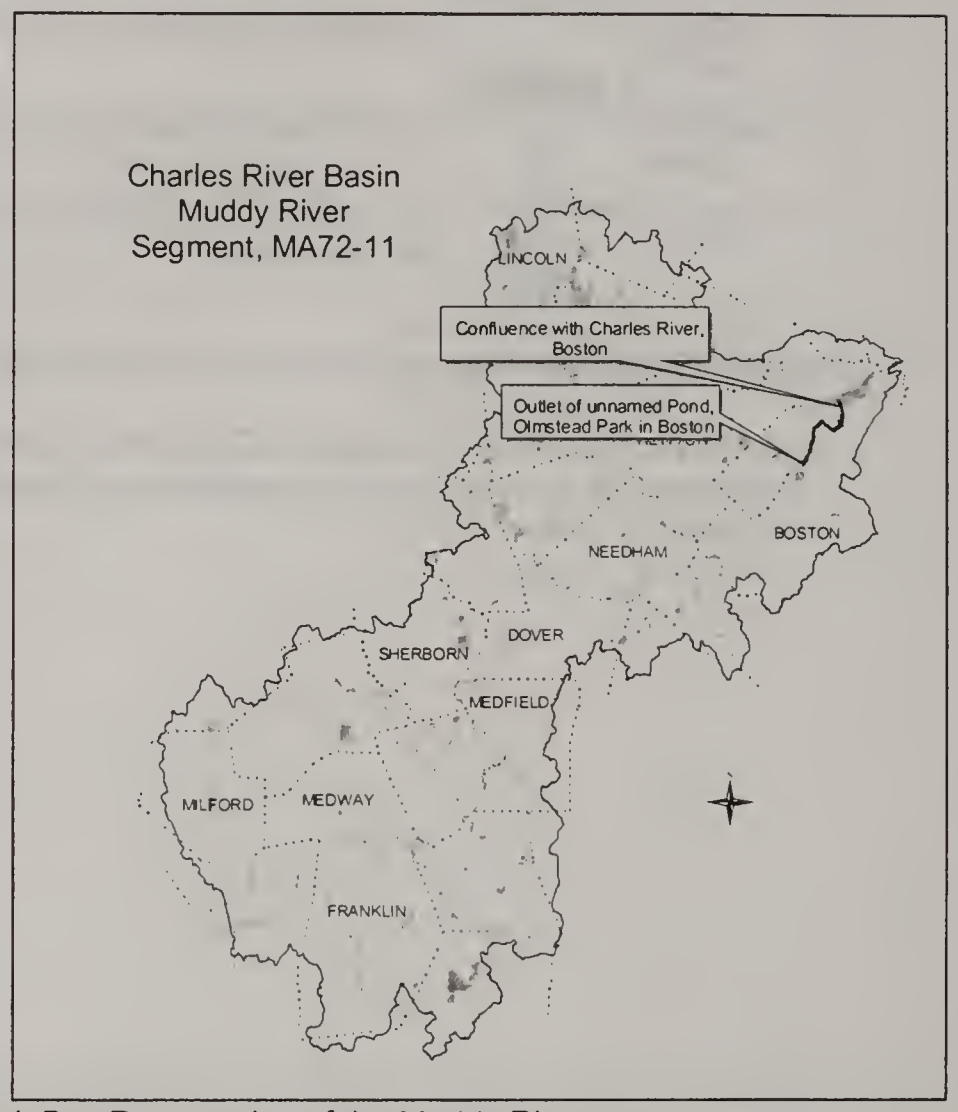
- Locate/isolate sources of elevated fecal coliform bacteria inputs to the stream, making necessary infrastructures upgrades to eliminate illicit sewer connections and dry weather storm drain discharges to the stream.

MUDDY RIVER (SEGMENT MA72-11)

Location: Outlet of unnamed pond in Olmstead Park, Boston to confluence with Charles River.
Segment Length: 4.2 miles. Classification: Class B, Warm Water Fishery.

SEGMENT DESCRIPTION

The drainage area of the Muddy River originates in an unnamed pond immediately downstream from Jamaica Pond and joins the mainstem Charles River just upstream from the Harvard Bridge. It has historically exhibited degraded water quality due to CSOs, stormdrain discharges (dry and wet weather) and other sources of urban runoff. From Olmstead Park, the stream flows in a northeasterly direction through Olmstead Park and the urbanized neighborhoods of Brookline Village and Longwood. Just past the Longwood medical area the river heads south past several colleges before entering the Back Bay Fens Park. From here it meanders north again joining the Charles River just upstream from Massachusetts Avenue in the Back Bay section of Boston.



WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0034410 Brookley Reality Trust
2. MA0036102 Star Enterprise
3. MA0034401 Terraces Condominium
4. MA0030783 Mobil Service Station

Other:

1. Overflows from the combined sewer system currently are released through Boston Gatehouse Nos. 1 and 2 to the Back Bay Fens portion of the Muddy River.

USE ASSESSMENT

The Corps of Engineers conducted fecal coliform bacteria sampling at 13 stations on two dry weather dates and one wet weather event during the summer of 1992 (U.S. Army Corps of Engineers 1992). Bacteria counts were generally found to exceed Class B standards for nearly all stations on both dry weather sampling occasions. Fecal coliform densities ranged from < 100 to 18,000 cfu/100ml. Fecal coliform densities were significantly higher during the wet weather sampling event, ranging from < 100 – 490,000 cfu/100ml. Highly elevated fecal coliform bacteria counts (between 60 – 68800 cfu/100ml during baseline conditions and 130–23000 cfu/100 during wet weather conditions) were also documented by the IM3 Project at their sampling station in the Muddy River near Commonwealth Avenue (CRWA 1998). Based on the findings of both the Corps and CRWA, the entire 4.2 miles of this segment are assessed as non-support for both primary and secondary contact due to pathogens.

The U.S. Army Corps of Engineers took dissolved oxygen measurements at 13 stations during June and September 1992, and at 12 stations during August 1992. There were several exceedences of the 5.0 mg/L standard on all dates, with the lowest levels measured downstream from Route 9 during dry weather and Brookline Avenue during wet weather (U.S. Army Corps of Engineers 1992). More than half the stations had levels < 5.0 mg/L during either dry or wet weather and extremely high levels of nutrients were also documented. Ammonia-nitrogen and phosphorus levels were particularly high downstream from the

Tannery Brook drain and throughout the Fens portion of the river, with values as high as 4.9mg/L for ammonia-nitrogen and 0.72mg/L for phosphorus.

The Corps also completed a sediment sampling program for the Muddy River in October 1997 (Breault *et al.* 1998). Trace metals and organic compounds (exceeding L-EL and S-EL recommended guidelines in Persaud *et al.* 1993) were documented in the Muddy Brook sediments. These contaminants were generally detected in the lowest concentrations in erosional areas far removed from storm-drain inputs; the highest concentrations were detected in depositional areas near the following major drainage outfalls: Daisy Field, Village Brook, Huntington Avenue, Tannery Brook, Emmanuel College, and Stony Brook (Breault *et al.* 1998).

Based on the data described above, the entire 4.2 miles of this segment is assessed as non-support for the aquatic life use due to low dissolved oxygen, organic enrichment, elevated nutrients, sediment contamination and severely degraded instream habitat quality (primarily sedimentation).

Aesthetics is also non-supported for the entire 4.2 miles of this segment. High levels of turbidity, occasional observations of objectionable solids and silt deposits, oil and grease, and sewage-related odors were documented by the Corps (1992) . In addition, excessive growth of nuisance aquatic vegetation (*Phragmites* sp. particularly in the Back Bay Fens portion of the river (Breault *et al.* 1998) contributed to the non-support assessment for the aesthetics use.

DWM conducted fish toxics monitoring in July 1990. Elevated levels of PCB's in carp, bullhead, and American Eel, resulted in an DPH-issued fish consumption advisory for these species for the 4.2 miles of this segment (DPH 1998).

SUMMARY

Designated Uses		Status
Aquatic Life		The entire 4.2 miles of the segment are assessed as non-support due to low DO/organic enrichment, nutrients, and sedimentation.
Fish Consumption		The entire 4.2 miles of this segment are assessed as non-support due to elevated levels of PCB's in carp, bullhead, and American eel.
Primary Contact		The entire 4.2 miles of this segment are assessed as non-support due to pathogens associated with stormwater, CSOs, and other unknown sources of unknown runoff.
Secondary Contact		The entire 4.2 miles of this segment are assessed as non-support due to pathogens associated with stormwater, CSOs, and other unknown sources of unknown runoff.
Aesthetics		The entire 4.2 miles of this segment are assessed as non-support due to turbidity, odors, objectionable solids/siltation, oil and grease, and nuisance aquatic vegetation.

RECOMMENDATIONS: Muddy River (Segment MA72-11)

Recommendations for flood control and water quality improvements in the Muddy River were outlined by the Corps of Engineers in their Water Resources Study of the Muddy River Watershed (1992). A brief summary of these recommendations is as follows:

- *Flood Control.* Both a Comprehensive Plan and a Minimum Plan were proposed. The Comprehensive Plan called for a 3.5 times greater increase in flow area upstream from the Brookline Avenue Gatehouse by modifying the diameter of the culverts near Louis Pasteur Avenue. Culvert modifications will result in altered sedimentation patterns, higher dissolved oxygen levels, and greater flushing capacity within the fens. Dredging will also be carried out in the area from the outlet of the culverts under Brookline Avenue to the Boylston Street Bridge, and should reduce the short-term benthic oxygen demand. An additional option called for the open channelization of the portion currently under the Sears parking lot, increasing surface area for reoxygenation. The Minimum Plan called for only a 2.6 times greater increase in flow area upstream from the Brookline Avenue gatehouse, with no dredging conducted. An additional option to this plan was to modify the culvert to the portion of the river under the Sears parking lot, rather than replacing the entire channel.

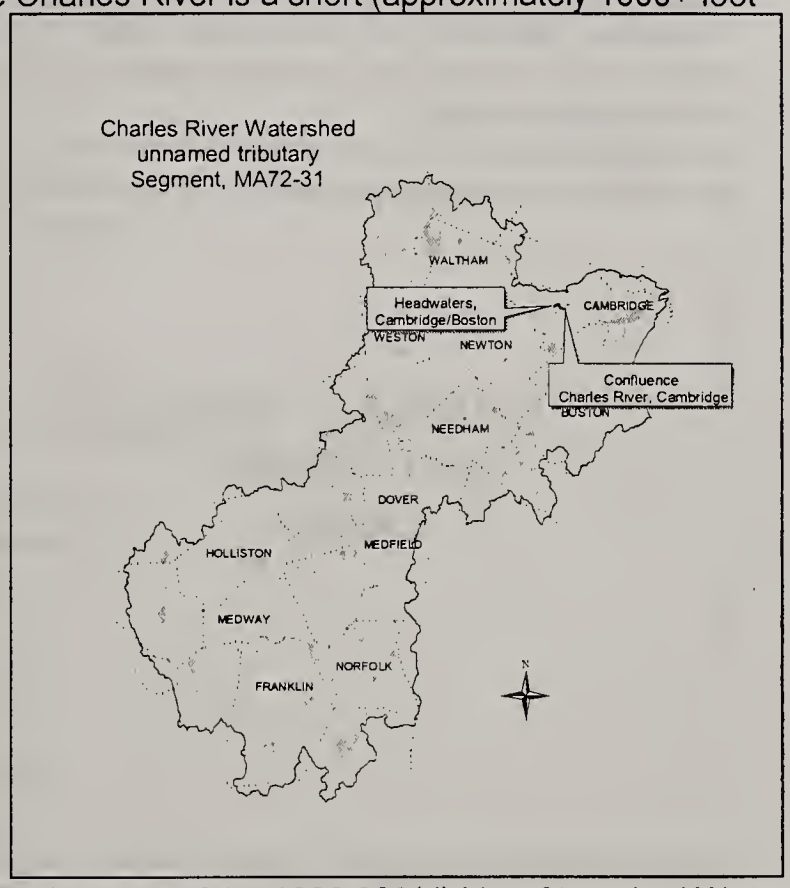
- *Water Quality*. 1) Source Control—The highest priority source control projects were the elimination of sewer cross connections from the Daisy Field, Tannery Brook, Village Brook, and Longwood Avenue drainage systems so there would be no dry weather sources of sewage discharge to the river. In addition, Brookline and Boston should implement or maintain BMPs to reduce stormdrain pollutants. 2) Instream Treatment/Dissolved Oxygen Addition—This recommendation called for the operation of a treatment facility and/or dissolved oxygen bubbler system to treat the symptoms of a polluted stream by accelerating nature's self-cleansing properties. While details of the system were not included in the water Resources Study, a proposal for a demonstration project was being developed by professors from Northeastern University and a former official from MDWPC. 3) Flow Augmentation—Flow augmentation was recommended to deter sedimentation and help maintain the river's assimilation capacity. Specifically, the Corps recommended modification of the Brookline Avenue Gatehouse to allow more riverflow to pass away from the Muddy River conduit and through the back Bay Fens area, and release of municipal or well water to the upper Muddy River. Source control improvements must accompany this alternative. 4) Dredging the River to improve water quality—dredging will provide dramatic short-term improvement as the source of high benthic oxygen demand is eliminated. 5) Selective Removal of *Phragmites* sp.—This alternative was recommended to improve riverine habitat and restore scenic vistas.

UNNAMED TRIBUTARY (SEGMENT MA72-31)

Location: Headwaters, Cambridge/Boston to the confluence with the Charles River, Cambridge.
Segment Length: 0.2 miles. Classification: Class B

SEGMENT DESCRIPTION

Locally known as the "Millers River", this tributary of the Charles River is a short (approximately 1000+ foot long by 80 foot wide) partially vegetated watercourse. This tributary to the Charles River is located within a highly industrialized area (headwater drainage area includes portions of Cambridge, Somerville and Boston. The corporate boundary between the cities of Boston and Cambridge lies along its eastern bank. The "Millers River" flows in a southeasterly direction to its confluence with the Charles River between the Science Museum Dam and the New Charles River Dam in Boston.



WITHDRAWALS AND DISCHARGES

Other:
1. Numerous stormdrain discharges.

USE ASSESSMENT

This watercourse (akin to a drainage ditch) conveys stormwater runoff and some base flow to the Charles River just upstream from the MDC Gridley Dam/Locks. The river has been culverted and filled over time and what remains is very degraded. In the development of the 1998 303(d) List of Impaired Waters in Massachusetts, information was provided to the DEP DWM supporting the inclusion of the "Millers River" on the List. Sediment sampling in the Millers River, documented elevated levels of heavy metals, PCB, Total Petroleum Hydrocarbons and, PAHs (CDM 1995). A preliminary assessment and risk characterization of the Millers River conducted by GeoEnvironmental, Inc. (GZA) for the Massachusetts Bay Transportation Authority (MBTA) Commuter Rail Maintenance Facility also provided data indicative of contamination in the Millers River (GZA GeoEnvironmental, Inc 1998). Furthermore their report stated that no fish were observed during an electroshock fishing effort.

SUMMARY

Designated Uses		Status
Aquatic Life		The entire 0.2 miles of the segment are assessed as non-support due sediment contamination.
Fish Consumption		Not assessed.
Primary Contact		The entire 0.2 miles of the segment are assessed as non-support due aesthetic degradation.
Secondary Contact		The entire 0.2 miles of the segment are assessed as non-support due aesthetic degradation.
Aesthetics		The entire 0.2 miles of the segment are assessed as non-support due objectionable deposits and scums.

RECOMMENDATIONS: Unnamed tributary (Segment MA72-31)

- Continue to pursue remediation/habitat restoration (waste site clean-up, stormwater permits, MBTA Commuter Rail Maintenance Facility upgrades).

CHARLES RIVER WATERSHED – LAKE/POND ASSESSMENTS

A total of 41 lakes, ponds or impoundments (the term "lakes" will hereafter be used to include all) have been assessed in the Charles River Watershed (Figure 7). Twenty-two of the lakes are less than 50 acres in total surface area, but only 4 are less than ten acres. The lakes surveyed in 1997 are located wholly or partly within 22 different communities and are fairly evenly distributed among them. Only two towns (Holliston and Weston) contain as many as five of the surveyed lakes. The total surface acreage of the Charles Watershed lakes is 4,165 (Ackerman, 1989). Of that total, 69%, or 2,875 acres, was assessed during the 1997 surveys. Designated water supplies (i.e., Class A) accounted for about a third (33% or 945 acres) of the assessed acreage.

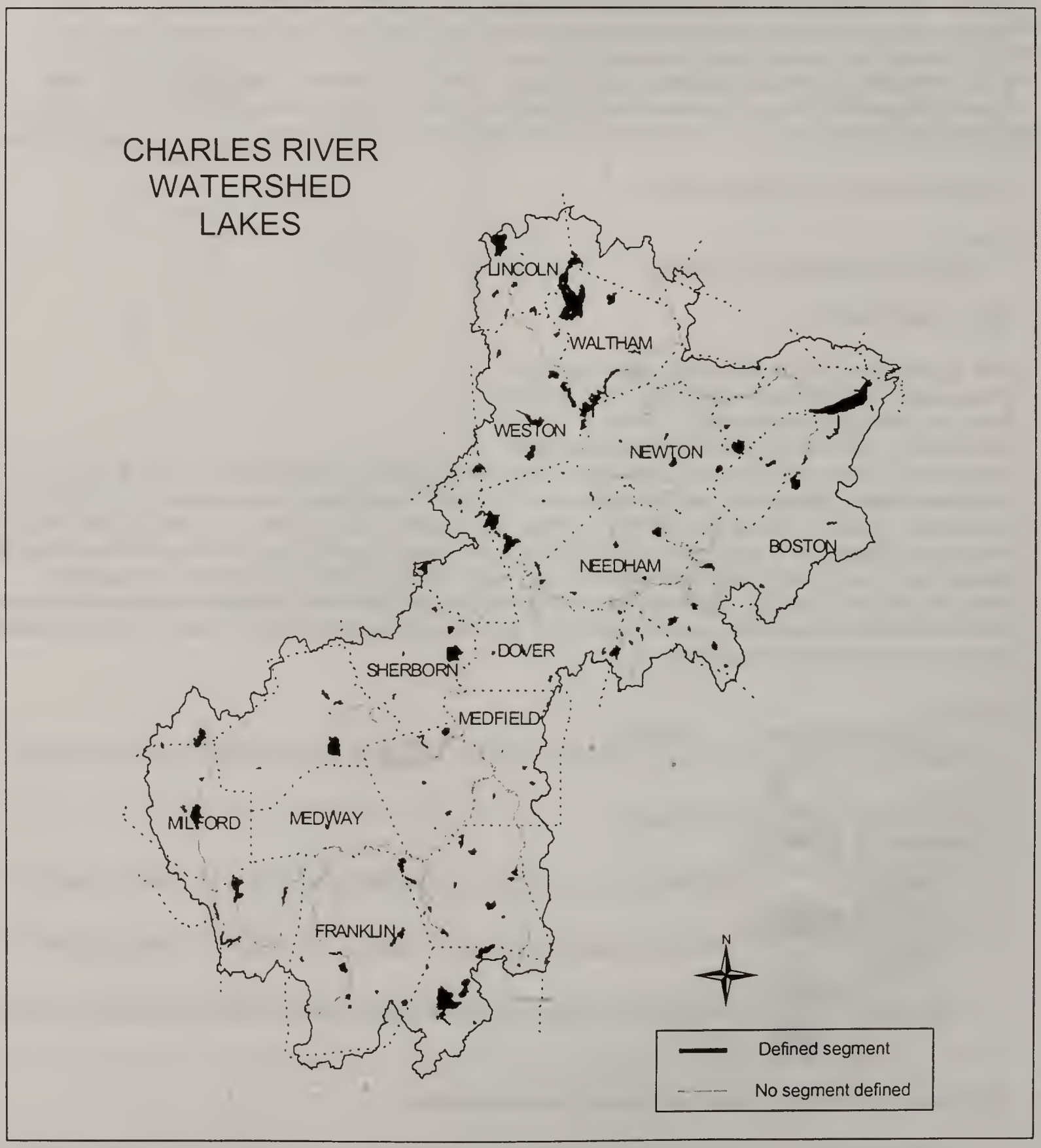


Figure 7. Location of assessed lakes in the Charles River Watershed.

LAKE USE ASSESSMENTS

Synoptic surveys were conducted, during the summer of 1997, at a total of 41 lakes in the Charles River Watershed. Surveys consisted of taking observations from at least one access point on each lake (multiple access points on larger lakes). At each lake, an attempt was made to observe the entire surface area to determine the extent of areal macrophyte cover. The trophic status of each lake was estimated and the presence of non-native aquatic and/or wetland plant species was also noted (Appendix B, Table B8). The data gathered during these synoptic surveys, as well as DPH Fish Consumption Advisories (DPH 1998), were used to assess the status the designated uses.

AQUATIC LIFE

Individual lake survey data are presented in Appendix B, Table B8. Surveys focused on the presence or absence of non-native macrophytes. Six non-native aquatic species and two non-native wetland species were observed in the Charles River Watershed lakes, as follows.

Non-native Aquatic Plants

Cabomba caroliniana - Fanwort
Myriophyllum heterophyllum - Variable water milfoil
M. spicatum - Eurasian water milfoil
Nymphoides peltatum - Yellow floating heart
Potamogeton crispus - Curly leaf pondweed
Trapa natans - Water chestnut

Non-native Wetland Plants

Lythrum salicaria - Purple loosestrife
Phragmites australis – Common reed grass

Of the 41 lakes surveyed, nine, or 22 % had a confirmed non-native aquatic macrophyte observed. In the case of wetland species 30, or 73 %, lakes had non-natives associated with them.

Non-native plant species represent a special cause of impairment that is not always directly related to the cultural eutrophication process. Since these species are introduced from other parts of the country or world they are generally free from the natural control mechanisms (e.g., insects or diseases) that keep most native plant populations in check. Without controls the populations of many non-native species can grow rapidly to out-compete native plant species. This growth habit is termed invasive. It throws the biological community out of balance and can impair uses such as swimming (primary contact) and boating (secondary contact). In Massachusetts, the Division of Watershed Management is tracking the distribution of about a dozen of these non-native aquatic and wetland plant species and the impairment they are causing.

In the Charles River Watershed five non-native, aquatic plant species were only found infrequently. A sixth species (*Myriophyllum heterophyllum*) was found more commonly. Most of these species have a good potential for spreading downstream and may have already done so into unsurveyed lakes or segments of tributaries. *Cabomba caroliniana*, *M. heterophyllum*, and *M. spicatum* are particularly invasive species that spread vegetatively via cuttings that may float downstream or be transported mechanically between lakes. *Nymphoides peltatum*, *Potamogeton crispus*, and *Trapa natans* spread readily from seeds, which may be transported downstream to sprout in new locations. The nutlets of the water chestnut, *T. natans*, are more likely transported to new locations via waterfowl or aquatic mammals.

The listings below indicate where non-native, aquatic species have been observed (**in bold**) and the likely, or potential, avenues of downstream spreading:

Cabomba caroliniana **(Fanwort)**

-- **Morses Pond** (Wellesley) ⇒ unnamed tributary ⇒ Paintshop Pond ⇒ unnamed tributary ⇒ **Lake Waban**(Wellesley) ⇒ Waban Brook ⇒ Charles River (Wellesley)

-- **Lake Winthrop** (Holliston) ⇒ Winthrop Canal ⇒ Linden Pond ⇒ unnamed tributary ⇒ Factory Pond ⇒ Bogastow Brook (through Bogastow Pond) ⇒ South End Pond ⇒ unnamed tributary ⇒ Charles River (Millis)

Myriophyllum heterophyllum **(Variable water milfoil)**

-- **Lake Winthrop** (Holliston) ⇒ Winthrop Canal ⇒ Linden Pond ⇒ unnamed tributary ⇒ **Factory Pond** ⇒ **Houghton Pond** (Holliston) ⇒ unnamed tributary ⇒⇑ Bogastow Brook (through Bogastow Pond) ⇒ South End Pond ⇒ unnamed tributary ⇒ Charles River (Millis)

-- **Morses Pond** (Wellesley) ⇒ unnamed tributary ⇒ Paintshop Pond ⇒ unnamed tributary ⇒ **Lake Waban** (Wellesley) ⇒ Waban Brook ⇒ Charles River (Wellesley)

-- **Noannet Pond** (Dover/Westwood) ⇒ Powissett Brook (through Storrow Pond and other unnamed ponds) ⇒ Charles River (Dover)

Myriophyllum spicatum **(Eurasian water milfoil)**

-- **Morses Pond** (Wellesley) ⇒ unnamed tributary ⇒ Paintshop Pond ⇒ unnamed tributary ⇒ **Lake Waban** (Wellesley) ⇒ Waban Brook ⇒ Charles River (Wellesley)

Nymphoides peltatum **(Yellow floating heart)**

-- **Scarborough Golf Course Pond** (Boston) ?Isolated? or ⇒ unnamed tributary ⇒ Jamaica Pond ⇒ MuddyRiver (through Back Bay Fens) ⇒ Charles River (Boston)

Potamogeton crispus **(Curly leaf pondweed)**

-- **Mirror Lake** (Wrentham) ⇒ unnamed tributary ⇒ Stony Brook (through Stony Brook Pond) ⇒ Stop River (through Highland Lake) ⇒ Charles River (Medfield).

Trapa natans **(Water chestnut)**

-- **Hardy Pond** (Waltham) ⇒ unnamed tributary (channelized) ⇒ Beaver Brook (through small ponds) ⇒ Lyman Pond ⇒ unnamed tributary ⇒ Charles River (Waltham, Watertown, and Brighton)

FISH CONSUMPTION

The fish consumption use assessments were based strictly on the DPHs fish consumption advisory list (1998). In addition to the statewide DPH health advisory, which warns that pregnant women should not consume fish from any inland Massachusetts waters, there are three non-consumption advisories in effect for lakes in the Charles River Watershed.

- Cedar Swamp Pond, Milford: children under 12 years of age, pregnant women, and nursing mothers not consume any fish species from that waterbody because of mercury hazard. All other people should limit consumption of any fish species to two (2) meals per month.
- Populatic Pond, Norfolk: children under 12 years of age, pregnant women, and nursing mothers not consume largemouth bass from that waterbody because of mercury hazard. All other people should limit consumption of this species to two (2) meals per month. (This pond is an impounded section of the Charles River mainstem -- see river segment MA72-04).
- Lake Winthrop, Holliston: the general public should not consume any fish from that waterbody because of a dioxin hazard.

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS

Because the synoptic surveys focus on just three criteria (macrophyte cover, transparency, and biocommunity modifications) only a few uses could be assessed fully. Since macrophyte cover is the only criterion used to assess the secondary contact recreation, this use category was assessed at each lake surveyed. Lakes exhibiting impairment of the primary contact recreation use (swimmable) because of macrophyte cover and/or transparency were noted as either partial or non-support. However, if a lake met these criteria it, or part of its area, was listed as not assessed because no data were available for fecal coliform bacteria. The same approach was used for assessing the aquatic life use category since no dissolved oxygen data were available. The aesthetic use category was generally assessed at the same level of impairment as the more severely impaired recreational use category (primary or secondary contact recreation).

SUMMARY

With the above qualifications for the overall assessment of lake resources in the Charles River Watershed, the surveys indicated that the use of 40% of the surveyed surface acreage is impaired or unusable for some or all of its designated uses Table 1 (Executive Summary). Observations at two lakes, Cedar Swamp Pond in Milford and Jennings Pond in Natick, showed extensive loss of open water habitat due to changes in water level, either intended or unintended.

Due to the focus of the surveys conducted, the major cause for use impairment was aquatic plants, either native or non-native (Table 4). Turbidity is also noted occasionally as a cause. These causes may reflect symptoms of lake eutrophication, a process of enrichment from excessive plant nutrients and sediments being introduced to the lakes from cultural sources. This phenomenon is also reflected in the distribution of lake trophic conditions, which is skewed toward the more eutrophic categories. The only other causes listed for impaired lakes in this watershed are metals (mercury) and pesticides (dioxin), which are associated with the fish consumption advisories listed by the Department of Public Health. Flow alteration resulted in large portions of two ponds, Cedar Swamp Pond in Milford and Jennings Pond in Natick being listed as not attainable because the water level (for reasons unknown) was too low to support any aquatic uses.

The sources of impairment are largely unknown, at least based on direct knowledge. However, it can be surmised that nutrients delivered from stormwater runoff and other non-point sources are likely to cause the increased algal or macrophyte productivity that has resulted in impairments.

RECOMMENDATIONS

For non-native aquatic or wetland plant species that were isolated to one or a few location(s) (*Cabomba caroliniana*, *Myriophyllum spicatum, Nymphoides peltatum*, *Potamogeton crispus*, *Trapa natans*, and *Phragmites austalis*), quick action is advisable to manage these populations in order to alleviate the need for costly and potentially fruitless efforts to do so in the future. Two courses of action should be pursued concurrently. More extensive surveys need to be conducted, particularly downstream from these recorded

locations, to determine the extent of the infestation. And, "spot" treatments should be undertaken to control populations at these sites before they spread further. These treatments may be in the form of carefully hand pulling individual plants, in small areas, or selective herbicide applications in larger areas. In either case, the treatments should be undertaken prior to fruit formation and with a minimum of fragmentation of the individual plants. These cautions will minimize the spreading of the populations.

One particular infestation of water chestnut, in the Charles River Lakes District in Newton and Waltham, is so severe that mechanical harvesting is currently being implemented. It is recommended that this control strategy be continued.

The aquatic species *Myriophyllum heterophyllum* and the wetland species *Lythrum Salicaria* have become more widespread in the Charles River Watershed lakes and wetlands. Accordingly these species will require an extensive program aimed at 1) determining the extent of the distribution, 2) reducing impairment, and 3) controlling further spreading to unaffected waterbodies.

As with the isolated cases, a program to manage the more extensive plant infestations should include additional monitoring efforts to determine the extent of the problem. Plant control aspects of any plan to manage the non-native aquatic species mentioned above can select from several techniques (e.g., bottom barriers, drawdown, herbicides, etc.), each of which has advantages and disadvantages that need to be addressed for the specific site. However, methods that result in fragmentation (such as cutting or raking) should be discouraged because of the propensity for these plants to reproduce and spread vegetatively (from cuttings).

Another important component of a management plan is prevention of further spreading of these plants. Once the extent of the problem is determined and control practices are exercised, vigilant monitoring needs to be practiced to guard against infestations occurring in unaffected areas and to ensure that managed areas stay in check. A key portion of the prevention program should be posting of boat access points with signs to educate and alert lake users to the problem and responsibility.

Table 4. Charles River Watershed Lake Assessments (summer 1997).

LAKE	LOCATION	SIZE (Acres)	TROPHIC STATE	USE ATTAINMENT (Acres)	IMPAIRMENT CAUSE(S)
Lake Archer	Wrentham	79	M	2° Contact-F(79) Aesthetics-F(79)	
Beaver Pond	Bellingham/ Milford	114	E	1° Contact-P(59);N(55) 2° Contact- P(59);N(55) Aesthetics- P(59);N(55)	Noxious plants Turbidity
Box Pond	Bellingham/ Mendon	46	H	1° Contact-N(46) 2° Contact-N(46) Aesthetics-N(46)	Noxious plants
Cambridge Reservoir **	Waltham/ Lincoln/ Lexington	549	U	2° Contact-F(549) Aesthetics-F(549)	
Cambridge Reservoir, Upper Basin **	Lincoln/ Lexington	44	U	1° Contact-N(44) 2° Contact-N(44) Aesthetics-N(44)	Noxious plants Turbidity
Cedar Swamp Pond	Milford	95	H	Aquatic Life-U(5);NA(90) Fish Consumption-N(5);NA(90) 1° Contact- N(5);NA(90) 2° Contact- N(5);NA(90) Aesthetics- N(5);NA(90)	Noxious plants Metals (Hg) Flow alteration
Chestnut Hill Reservoir	Boston	101	U	2° Contact-F(101) Aesthetics-F(101)	
Crystal Lake	Newton	24	U	2° Contact-F(24) Aesthetics-F(24)	
Dug Pond	Natick	49	U	2° Contact-F(49) Aesthetics-F(49)	
Echo Lake **	Milford/ Hopkinton	123	M	2° Contact-F(123) Aesthetics-F(123)	
Factory Pond	Holliston	10	H	Aquatic Life-P(10) 1° Contact-N(10) 2° Contact-N(10) Aesthetics-N(10)	Non-native plants (Mh) Noxious plants

** Indicates Class A (water supply) waterbody; all others are Class B. INFORMATION CODES: **Trophic State**-- O= Oligotrophic, M= Mesotrophic, E= Eutrophic, H= Hypereutrophic, U= Undetermined. **Use Attainment**-- N= Non-support, P= Partial support, F= Full support, T= Threatened, NA= Not-attainable, U= Undetermined. **Non-native Plants**-- Cc= *Cabomba caroliniana*, Mh= *Myriophyllum heterophyllum*, Ms= *Myriophyllum spicatum*, Np= *Nymphoides peltatum*, Pc= *Potamogeton crispus*, Tn= *Trapa natans.*

Table 4. Charles River Watershed Lake Assessments (summer 1997). (Continued)

LAKE	LOCATION	SIZE (Acres)	TROPHIC STATE	USE ATTAINMENT (Acres)	IMPAIRMENT CAUSE(S)
Farm Pond	Sherborn	124	U	2° Contact-F(124) Aesthetics-F(124)	
Franklin Reservoir, NE	Northeast Franklin	21	E	1° Contact-P(8),N(7),U(6) 2° Contact- P(8),N(7),U(6) Aesthetics- P(8),N(7),U(6)	Noxious plants Turbidity
Franklin Reservoir, SW	Southwest Franklin	13	E	1° Contact-P(3),N(7),U(3) 2° Contact- P(3),N(7),U(3) Aesthetics- P(3),N(7),U(3)	Noxious plants Turbidity
Hammond Pond	Newton	21	E	1° Contact-N(10);U(11) 2° Contact-F(11);N(10) Aesthetics-F(11);N(10)	Noxious plants
Hardy Pond	Waltham	41	H	Aquatic Life-P(41) 1° Contact-P(25);N(16) 2° Contact-P(25);N(16) Aesthetics-P(25);N(16)	Non-native plants (Tn) Noxious plants Turbidity
Houghton Pond	Holliston	17	H	Aquatic Life-P(17) 1° Contact-P(5);N(12) 2° Contact-P(5);N(12) Aesthetics- P(5);N(12)	Non-native plants (Mh) Noxious plants Turbidity
Jamaica Pond	Boston	63	U	2° Contact-F(63) Aesthetics-F(63)	
Jennings Pond	Natick	9	H	Aquatic Life-U(2);NA(7) Fish Consumption-U(2);NA(7) 1° Contact-N(2);NA(7) 2° Contact- N(2);NA(7) Aesthetics- N(2);NA(7)	Noxious plants Flow alteration
Kendrick Street Pond	Needham	49	E	1° Contact-P(49) 2° Contact-F(49) Aesthetics-F(49)	Turbidity

** Indicates Class A (water supply) waterbody; all others are Class B. INFORMATION CODES: **Trophic State**—O= Oligotrophic, M= Mesotrophic, E= Eutrophic, H= Hypereutrophic, U= Undetermined. **Use Attainment**—N= Non-support, P= Partial support, F= Full support, T= Threatened, NA= Not-attainable, U= Undetermined. **Non-native Plants**—Cc= *Cabomba caroliniana*, Mh= *Myriophyllum heterophyllum*, Ms= *Myriophyllum spicatum*, Np= *Nymphoides peltatum*, Pc= *Potamogeton crispus*, Tn= *Trapa natans*.

Table 4. Charles River Watershed Lake Assessments (summer 1997). (Continued)

LAKE	LOCATION	SIZE (Acres)	TROPHIC STATE	USE ATTAINMENT (Acres)	IMPAIRMENT CAUSE(S)
Linden Pond	Holliston	1	H	1° Contact-N(1) 2° Contact-N(1) Aesthetics-N(1)	Noxious plants Turbidity
Little Farm Pond	Sherborn	22	H	1° Contact-N(12);U(10) 2° Contact- N(12);U(10) Aesthetics- N(12);U(10)	Noxious plants
Lymans Pond	Dover	3	H	1° Contact-P(1);N(2) 2° Contact- P(1);N(2) Aesthetics- P(1);N(2)	Noxious plants Turbidity
Mine Brook Pond	Franklin	72	H	1° Contact-N(72) 2° Contact-N(72) Aesthetics-N(72)	Noxious plants Turbidity
Mirror Lake	Wrentham/ Norfolk	55	E	Aquatic Life-P(55) 1° Contact-P(55) 2° Contact-F(40);P(15) Aesthetics-F(40);P(15)	Non-native plants (Pc) Noxious plants Turbidity
Morses Pond	Wellesley/ Natick	116	E	Aquatic Life-P(116) 1° Contact-N(15);U(111) 2° Contact-F(111);N(15) Aesthetics-F(111);N(15)	Non-native plants (Cc, Mh, Ms) Noxious plants
Noannet Pond	Dover/ Westwood	58	U	Aquatic Life-P(58) 2° Contact-F(58) Aesthetics-F(58)	Non-native plants (Mh)
Nonesuch Pond	Weston/ Natick	35	U	2° Contact-F(35) Aesthetics-F(35)	
Norumbega Reservoir (North Basin)	Weston	14	U	2° Contact-F(14) Aesthetics-F(14)	
Norumbega Reservoir (South Basin)	Weston	36	U	2° Contact-F(36) Aesthetics-F(36)	

** Indicates Class A (water supply) waterbody; all others are Class B. INFORMATION CODES: **Trophic State**—O= Oligotrophic, M= Mesotrophic, E= Eutrophic, H= Hypereutrophic, U= Undetermined. **Use Attainment**—N= Non-support, P= Partial support, F= Full support, T= Threatened, NA= Not-attainable, U= Undetermined. **Non-native Plants**—Cc= *Cabomba caroliniana*, Mh= *Myriophyllum heterophyllum*, Ms= *Myriophyllum spicatum*, Np= *Nymphoides peltatum*, Pc= *Potamogeton crispus*, Tn= *Trapa natans.*

Table 4. Charles River Watershed Lake Assessments (summer 1997). (Continued)

LAKE	LOCATION	SIZE (Acres)	TROPHIC STATE	USE ATTAINMENT (Acres)	IMPAIRMENT CAUSE(S)
Lake Pearl	Wrentham	218	M	2° Contact-F(218) Aesthetics-F(218)	
Populatic Pond	Norfolk	40	E	Fish Consumption-N(40) 1° Contact-P(40) 2° Contact-P(40) Aesthetics-P(40)	Metals (Hg) Noxious plants Turbidity
Sandy Pond **	Lincoln	162	M	2° Contact-F(162) Aesthetics-F(162)	
Scarboro Golf Course Pond	Boston	7	H	Aquatic Life-P(7)	Non-native plants (Np)
Stony Brook Reservoir **	Waltham/ Weston	67	U	2° Contact-F(67) Aesthetics-F(67)	
Lake Waban	Wellesley	108	U	Aquatic Life-P(108) 2° Contact-F(108) Aesthetics-F(108)	Non-native plants (Cc, Ms)
Waseeka Sanctuary Pond	Holliston	17	H	1° Contact-N(17) 2° Contact-N(17) Aesthetics-N(17)	Noxious plants
Weld Pond	Dedham	27	E	1° Contact-N(13);U(14) 2° Contact-F(14);N(13) Aesthetics-F(14);N(13)	Noxious plants
Weston Reservoir	Weston	60	U	2° Contact-F(60) Aesthetics-F(60)	
Weston Station Pond	Weston	63	E	1° Contact-N(63) 2° Contact- N(63) Aesthetics- N(63)	Noxious plants
Lake Winthrop	Holliston	102	E	Aquatic Life-P(102) Fish Consumption-N(102) 1° Contact-N(20);U(82) 2° Contact-F(82);N(20) Aesthetics-F(82);N(20)	Non-native plants (Cc, Mh) Noxious plants Pesticides (dioxin)

** Indicates Class A (water supply) waterbody; all others are Class B. INFORMATION CODES: **Trophic State**-- O= Oligotrophic, M= Mesotrophic, E= Eutrophic, H= Hypereutrophic, U= Undetermined. **Use Attainment**-- N= Non-support, P= Partial support, F= Full support, T= Threatened, NA= Not-attainable, U= Undetermined. **Non-native Plants**-- Cc= *Cabomba caroliniana*, Mh= *Myriophyllum heterophyllum*, Ms= *Myriophyllum spicatum*, Np= *Nymphoides peltatum*, Pc= *Potamogeton crispus*, Tn= *Trapa natans*.

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APPENDIX A – DEP DWM QA/QC

Introduction

Quality Assurance/Quality Control (QA/QC) activities were conducted as part of the DEP DWM Charles River Watershed Monitoring Survey in 1997/98. This QA/QC review was conducted to ensure that the collection and analysis of the monitoring data was of high quality. The 1997/98 monitoring data subjected to this QA/QC review includes the following: discrete water samples, fish tissue samples and *in-situ* water quality measurements. All discrete water sample and fish tissue monitoring data were reviewed independently by the Wall Experiment Station's (WES) Quality Assurance Program and the Division of Watershed Management's (DWM) Quality Assurance Officer and Assessment Coordinator. All *in-situ* water quality measurements were reviewed independently by DWM's Hydrolab® Instrument Coordinator and Database Manager. Data that fell outside established QA/QC acceptance criteria were investigated and may have been subject to censoring. This Quality Assurance/Quality Control appendix is divided into three sections: A.1 field and laboratory data objectives; A.2 QA/QC data; A.3 analytical methods.

A.1 Field and Laboratory QA/QC Objectives

Data collected by DWM in the 1997/98 Charles River survey was subject to field and laboratory data quality objectives. Section A.1.1 outlines the field collection objectives and laboratory quality control for discrete water samples. Section A.1.2 includes fish tissue laboratory quality control methods and Section A.1.3 includes Hydrolab QA/QC procedures.

A.1.1 Discrete Water Sample Data

FIELD

The collection of discrete water sample analytes followed DWM Standard Operating Procedures [1,2]. Four field collection quality control criteria were applied to the Charles River Watershed 1997/98 discrete water sample data:

1.0 Sampling/Analysis Holding Time: Each analyte has a standard holding time that has been established to ensure sample/analysis integrity. Refer to DWM Standard Operating Procedure Table 1.0 CN# 1.1 [2] for a complete listing. If the standard holding time was exceeded, this objective is violated.

2.0 Quality Control Sample Frequency: At a minimum, one field blank and one replicate must be collected for every ten samples by any given sampling crew on any given date. If less than one quality control sample per 10 field samples was collected, this objective is violated.

3.0 Field Blank: Field blanks were prepared at the DWM Worcester Office. Reagent grade water was transported into the field where it was transferred into a sample container and fixed using the same method as its corresponding field sample. All blanks were submitted to WES laboratory "blind". If the field blanks were significantly different (>2 standard deviations [9]) from the detection limit, this data quality objective is violated.

4.0 Field Replicate: Two independent samples were collected from the same location and as close as possible to the same time in the field. Both samples were submitted to WES laboratory "blind". In order for this data quality objective to be met, the results must be:

<20% Relative Percent Difference (RPD) for method detection limits >1mg/L
<30% RPD for method detection limits <1mg/L

A detailed QA/QC summary of the four data quality objectives and additional DWM quality assurance observations for the 1997/98 Charles River Watershed data can be found in the 1997/98 Watershed QA/QC Assessment Report [8].

LABORATORY

Discrete water sample analysis followed EPA-approved laboratory QA/QC methodologies in accordance with WES Standard Operating Procedures [3]. The quality of data generated at WES was determined by analyzing the results of a variety of quality control procedures including but not limited to:

Low Calibration Standards – Checks the stability of the instrument's calibration curve. Analyzes the accuracy of an instrument's calibration within a 5% range.

Reference Standards – Generally, a second source standard (a standard different from the calibration stock standard) that analyzes the accuracy of an instrument's calibration within a 5% range.

Laboratory Reagent Blank/Method Blank (LRB) – Reagent grade water (de-ionized) extracted with every sample set to ensure that the system is free of target analytes (< MDL).

Duplicate Sample – Measures the precision (% Relative Percent Difference) of the extraction and analytical process. The acceptable laboratory %RPD range is typically ≤ 25%.

Spike Sample (Laboratory Fortified Blank - LFB, Laboratory Fortified Matrix - LFM)– Measures the accuracy (% Recovery) of an analytical method. The acceptable laboratory % recovery range is typically between 80 – 120% for LFB samples and 70 –130% for LFM discrete water samples.

The WES Laboratory is solely responsible for the administration of its Quality Assurance Program and Standard Operating Procedures. The frequency of the laboratory's quality control procedure was at times inconsistent with their Quality Assurance Plan [3]. In these circumstances additional quality assurance procedures were used. Refer to WES's Quality Assurance Plan [3] for specific laboratory analytical QA/QC criteria. WES laboratory releases discrete water sample data when their established QA/QC criteria are met or the data are labeled as outside of these criteria.

A.1.2 Fish Tissue Data

Fish were collected and processed according to DWM's Quality Assurance Project Plan [4]. Tissue preparation and analysis strictly adhered to EPA-approved laboratory QA/QC methodologies in accordance with WES Standard Operating Procedures [6,7]. The quality of tissue data generated at WES was determined by incorporating a variety of quality control samples:

Laboratory Reagent Blank/Method Blank (LRB) – Clean clam tissue matrix extracted with every sample set to ensure that the system is free of target analytes (< MDL).

Laboratory Fortified Blank (LFB) – Clean clam tissue matrix spiked with a low concentration of target compounds. LFB results are used to establish accuracy of system's performance. The acceptable laboratory % recovery range is typically 80 – 120%.

Laboratory Fortified Matrix (LFM) – Tissue matrix spiked with a low concentration of a target compound. LFM results are used to establish accuracy of the extraction and analytical process. The acceptable laboratory % recovery range is typically between 70 – 130% for metal analysis and 60 –140% for PCB/Organochlorine Pesticide analysis

Quality Control Standard (QCS) – A pre-spiked secondary tissue sample. QCS results are used to establish accuracy in the extraction and test methods. The acceptable laboratory % recovery range is typically between 80–120%.

The WES Laboratory is solely responsible for the administration of its Quality Assurance Program and Standard Operating Procedures. The frequency of the laboratory's quality control procedure was at times inconsistent with their Quality Assurance Plan [3]. In these circumstances additional

quality assurance procedures were used. Refer to WES's Quality Assurance Plan [3] for specific laboratory analytical QA/QC criteria. WES laboratory releases tissue data when their established QA/QC criteria are met or the data are labeled as outside of these criteria.

A.1.3 *In-situ* Water Quality Analysis

Trained DWM staff members conducted *in-situ* measurements using a Hydrolab® Multiprobe Series 3 analyzer. The Hydrolab® Multiprobe Series 3 analyzer measures dissolved oxygen, temperature, pH, conductivity, depth and turbidity and calculates total dissolved solids and % saturation of oxygen. To ensure the quality of the *in-situ* data, the following QA/QC steps were taken:

1.0 Pre-Calibration: After each analytical probe on the Hydrolab® analyzer was calibrated, a pre-calibration check was conducted. A low ionic standard was first analyzed to check the accuracy of the instrument. Then an instrument check consisting of de-ionized water was analyzed to check the instrument for contamination. The instrument check criteria is based on de-ionized water that that had been stored and vented to the air for at least three days. If the pre-calibration check achieved the criteria in Table HL-1 then the instrument was ready for field analysis but if the pre-calibration check failed to achieve the low ionic standard criteria than the instrument was re-calibrated and a second low ionic and instrument check was analyzed. If the instrument failed to meet the established low ionic standard criteria a second time the Hydrolab® instrument could not be used to collect data and maintenance was scheduled. Refer to the DWM Hydrolab® Standard Operating Procedure [5].

2.0 Post Survey Check: Once the Hydrolab® was returned from field sampling, a post survey check was performed to ensure that no malfunction or damage had occurred to any of the Hydrolab® probes. The low ionic standard and the instrument check were re-analyzed. If the post survey check achieved the established criteria in Table HL-1, the data was deemed acceptable and was ready for the data reduction QA/QC step. If, however, the post calibration failed to meet the criteria, the Hydrolab® Coordinator investigated the cause and recommended censoring of affected data to the Database Manager.

3.0 Data Reduction: The Hydrolab® Coordinator and Database Manager reviewed the Hydrolab® data for instability, instrument malfunction, operator technique and aberrant trends. If any of these conditions were detected, the data was investigated and may have been recommended for censoring. The Database Manager electronically tagged all data recommended for censoring in the database.

Table A.1-1 Hydrolab® Multiprobe Series 3 analyzer pre and post calibration specifications.

Hydrolab® Analyte	**Low-Ionic Standard**	**Instrument Check ***
Dissolved Oxygen	Saturation Chart (dependant on temperature & barometric pressure)	
pH	6.90 ±1%	5.6 ±0.2 units
Specific Conductance	74 ±1%	1.0 ±1%
Turbidity	0.0 ±5%	0.0 ±5%
Temperature	Ambient ±0.15°C**	Ambient ±0.15°C**
Depth	Field Calibrated ±0.45m	Field Calibrated ±0.45m
Salinity	Not Applicable	0.0 ±0.2ppt
Redox	Not Applicable	0.0±20mV

* Based on Division of Watershed Management's filtered de-ionized water

** Compared to the DWM laboratory's wall thermometer

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A.2 QA/QC Data

Field blank and replicate sampling results for the discrete water quality sampling (physico/chemical and bacteriological) are provided in Tables A.2-1 through A.2-4. Tables A.2-5 and A.2-6 contain laboratory QA/QC data for organics in tissue analyses and metals in tissue analyses, respectively.

Table A.2-1. 1997/1998 DEP DWM Charles River Watershed instream physico/chemical QA/QC field blank data. (All units expressed in mg/L unless otherwise specified.)

		Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
Field Blank Sample													
72-0018	06/17/97	11:48	2.0	<0.66	--	<1.0	<2.5	--	--	--	<0.02	<0.02	0.01
72-0010	06/17/97	12:10	3.0	<0.66	--	<1.0	<2.5	--	--	--	<0.02	<0.02	<0.01
72-0056	07/14/97	12:00	3.0	<0.66	--	<1.0	<2.5	--	<0.1	--	<0.02	<0.02	<0.01
72-0064	07/14/97	12:50	2.0	<0.66	--	<1.0	<2.5	--	<0.1	--	<0.02	<0.02	<0.01
72-0084	08/20/97	11:39	3.0	<0.66	--	<1.0	<2.5	--	<0.1	--	<0.02	<0.02	<0.01
72-0075	08/20/97	12:50	3.0	<0.66	--	<1.0	<2.5	--	<0.1	--	<0.02	<0.02	<0.01
72-0107	10/07/97	13:40	2.0	<0.66	--	<1.0	**	--	<0.1	--	<0.02	<0.02	<0.01
72-0122	11/04/97	14:30	1.0	<0.66	--	<1.0	**	--	<0.1	--	<0.02	<0.02	<0.01
72-0126	12/09/97	9:35	2.0	<0.66	--	**	**	--	**	--	<0.02	<0.02	<0.01
72-0141	12/09/97	12:30	2.0	<0.66	--	**	**	--	**	--	<0.02	<0.02	<0.01
72-0162	03/17/98	9:00	<1.0	<0.66	--	2.0	<1.0	--	0.10	--	<0.02	<0.02	<0.01
72-0178	03/17/98	12:00	<1.0	<0.66	--	<1.0	<1.0	--	<0.1	--	<0.02	<0.02	<0.01
72-0199	04/22/98	**	<1.0	<0.66	--	<1.0	<1.0	--	<0.1	--	<0.02	<0.02	<0.01
72-0184	04/22/98	9:00	<1.0	<0.66	--	<1.0	<1.0	--	<0.1	--	<0.02	<0.02	<0.01

** = missing/censored data -- = no data

Table A.2-2. 1997/1998 DEP DWM Charles River Watershed instream physico/chemical QA/QC field replicate data. (All units expressed in mg/L unless otherwise specified.)

			Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
Unnamed and/or Undefined SARIS, Station: LB01														
72-0002	72-0003	06/17/97	8:16	35	64	--	80	<2.5	--	--	--	0.02	1.3	**
72-0003	72-0002	06/17/97	8:16	35	65	--	78	<2.5	--	--	--	0.02	1.3	**
Relative Percent Difference (RPD):				*0.0%*	*1.6%*		*2.5%*	*0.0%*				*0.0%*	*0.0%*	
72-0047	72-0048	07/14/97	9:07	44	67	--	100	<2.5	--	1.0	--	0.02	2.8	0.10
72-0048	72-0047	07/14/97	9:07	45	66	--	96	<2.5	--	1.0	--	0.02	2.8	0.10
Relative Percent Difference (RPD):				*2.2%*	*1.5%*		*4.1%*	*0.0%*		*0.0%*		*0.0%*	*0.0%*	*0.0%*
72-0066	72-0067	08/20/97	9:02	45	77	--	80	<2.5	--	6.2	--	<0.02	1.8	0.10
72-0067	72-0066	08/20/97	9:02	45	77	--	80	<2.5	--	6.7	--	<0.02	1.8	0.10
Relative Percent Difference (RPD):				*0.0%*	*0.0%*		*0.0%*	*0.0%*		*7.8%*		*0.0%*	*0.0%*	*0.0%*
72-0105	72-0106	10/07/97	13:21	33	65	--	63	**	--	0.90	--	<0.02	1.6	0.10
72-0106	72-0105	10/07/97	13:21	32	66	--	60	**	--	0.90	--	<0.02	1.7	0.10
Relative Percent Difference (RPD):				*3.1%*	*1.5%*		*4.9%*			*0.0%*		*0.0%*	*6.1%*	*0.0%*
72-0120	72-0121	11/04/97	14:24	35	59	--	45	<2.5	--	2.2	--	<0.02	1.2	0.11
72-0121	72-0120	11/04/97	14:24	35	59	--	45	<2.5	--	2.3	--	<0.02	1.2	0.11
Relative Percent Difference (RPD):				*0.0%*	*0.0%*		*0.0%*	*0.0%*		*4.4%*		*0.0%*	*0.0%*	*0.0%*
72-0124	72-0125	12/09/97	9:19	33	43	--	**	**	--	**	--	0.05	0.67	0.04
72-0125	72-0124	12/09/97	9:19	32	43	--	**	**	--	**	--	0.03	0.64	0.05
Relative Percent Difference (RPD):				*3.1%*	*0.0%*							*50.0%*	*4.6%*	*22.2%*
72-0160	72-0161	03/17/98	8:41	37	65	--	72	<1.0	--	2.1	--	0.08	1.5	0.06
72-0161	72-0160	03/17/98	8:41	38	67	--	110	1.2	--	2.0	--	0.08	1.5	0.05
Relative Percent Difference (RPD):				*2.7%*	*3.0%*		*41.8%*	*18.2%*		*4.9%*		*0.0%*	*0.0%*	*18.2%*
72-0181	72-0182	04/22/98	8:30	32	56	--	90	2.6	--	1.6	--	0.02	0.77	0.11
72-0182	72-0181	04/22/98	8:30	33	56	--	89	2.6	--	1.5	--	0.02	0.78	0.10
Relative Percent Difference (RPD):				*3.1%*	*0.0%*		*1.1%*	*0.0%*		*6.5%*		*0.0%*	*1.3%*	*9.5%*

* = interference ** = missing/censored data -- = no data

Table A.2-2. 1997/1998 DEP DWM Charles River Watershed instream physico/chemical QA/QC field replicate data. (All units expressed in mg/L unless otherwise specified.) (Continued)

			Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
ALDER BROOK, Station: AB01														
72-0139	72-0140	12/09/19	10:04	25	64	--	**	**	--	**	--	<0.02	1.5	0.03
72-0140	72-0139	12/09/19	10:04	24	65	--	**	**	--	**	--	<0.02	1.5	0.03
Relative Percent Difference (RPD):				*4.1%*	*1.6%*							*0.0%*	*0.0%*	*0.0%*
72-0197	72-0198	04/22/19	9:53	24	54	--	85	3.2	--	1.4	--	0.04	1.1	0.02
72-0198	72-0197	04/22/19	9:53	24	54	--	84	2.6	--	1.4	--	0.02	1.1	0.03
Relative Percent Difference (RPD):				*0.0%*	*0.0%*		*1.2%*	*20.7%*		*0.0%*		*66.7%*	*0.0%*	*40.0%*
WABAN BROOK, Station: WB01														
72-0172	72-0177	03/17/19	12:43	23	50	--	96	1.4	--	1.4	--	<0.02	0.45	0.02
72-0177	72-0172	03/17/19	12:43	20	51	--	86	1.2	--	1.3	--	0.02	0.45	0.02
Relative Percent Difference (RPD):				*14.0%*	*2.0%*		*11.0%*	*15.4%*		*7.4%*		*0.0%*	*0.0%*	*0.0%*
FULLER BROOK, Station: FB01														
72-0016	72-0017	06/17/19	13:56	58	95	--	78	<2.5	--	--	--	0.06	1.2	0.04
72-0017	72-0016	06/17/19	13:56	58	108	--	78	<2.5	--	--	--	0.04	1.2	0.06
Relative Percent Difference (RPD):				*0.0%*	*12.8%*		*0.0%*	*0.0%*				*40.0%*	*0.0%*	*40.0%*
72-0062	72-0063	07/14/19	12:32	54	85	--	92	<2.5	--	1.2	--	0.04	1.3	0.06
72-0063	72-0062	07/14/19	12:32	55	84	--	95	<2.5	--	1.5	--	0.05	1.2	0.05
Relative Percent Difference (RPD):				*1.8%*	*1.2%*		*3.2%*	*0.0%*		*22.2%*		*22.2%*	*8.0%*	*18.2%*
72-0082	72-0083	08/20/19	11:15	44	78	--	68	<2.5	--	1.0	--	0.03	0.93	0.06
72-0083	72-0082	08/20/19	11:15	44	78	--	70	<2.5	--	1.0	--	0.02	1.2	0.06
Relative Percent Difference (RPD):				*0.0%*	*0.0%*		*2.9%*	*0.0%*		*0.0%*		*40.0%*	*25.4%*	*0.0%*

* = interference ** = missing/censored data -- = no data

Table A.2-3. 1997/1998 DEP DWM Charles River Watershed instream bacteriological QA/QC field blank data. (Units expressed in colonies/100ml.)

			Time (24hr)	FECAL	E-COLI	ENTEROCOCCUS	AEROMONAS
Field Blank Sample							
72-0033	BLANK	07/01/1997	10:55	<20	--	<20	--
72-0045	BLANK	07/01/1997	11:35	<20	--	<20	--
72-0056	BLANK	07/14/1997	12:00	<20	<20	--	--
72-0064	BLANK	07/14/1997	12:50	<20	<20	--	--
72-0201	BLANK	08/19/1997	1:25	<20	<20	**	**
72-0084	BLANK	08/20/1997	11:39	<20	<20	**	**
72-0075	BLANK	08/20/1997	12:50	<20	<20	**	**
72-0107	BLANK	10/07/1997	13:40	<20	<20	--	<100
72-0122	BLANK	11/04/1997	14:30	<20	<20	--	--
72-0126	BLANK	12/09/1997	9:35	<20	<20	<20	<100
72-0141	BLANK	12/09/1997	12:30	<20	<20	<20	<100
72-0157	BLANK	01/28/1998	12:00	<20	<20	--	**
72-0162	BLANK	03/17/1998	9:00	<20	<20	<20	--
72-0178	BLANK	03/17/1998	12:00	<20	<20	<20	--
72-0199	BLANK	04/22/1998	**	<20	<20	--	--
72-0184	BLANK	04/22/1998	9:00	<20	<20	<20	--

** = missing/censored data -- = no data

Table A.2-4. 1997/1998 DEP DWM Charles River Watershed instream bacteriological QA/QC field replicate data (units in colonies/100 ml, data log10 transformed).

			Time (24hr)	FECAL	E-COLI	ENTEROCOCCUS	AEROMONAS
Unnamed and/or Undefined SARIS, Station: BB01							
72-0086	72-0087	08/19/1997	11:50	2.447	1.602	**	4.462
72-0087	72-0086	08/19/1997	11:50	2.447	<1.301	**	4.740
Relative Percent Difference (RPD):				*0.0%*	*20.7%*		*6.0%*
Unnamed and/or Undefined SARIS, Station: LB01							
72-0047	72-0048	07/14/1997	9:07	2.415	1.778	--	--
72-0048	72-0047	07/14/1997	9:07	2.380	2.204	--	--
Relative Percent Difference (RPD):				*1.4%*	*21.4%*		
72-0066	72-0067	08/20/1997	9:02	2.380	2.000	**	4.568
72-0067	72-0066	08/20/1997	9:02	2.477	2.380	**	4.653
Relative Percent Difference (RPD):				*4.0%*	*17.4%*		*1.8%*
72-0105	72-0106	10/07/1997	13:21	2.881	2.505	--	4.146
72-0106	72-0105	10/07/1997	13:21	2.778	2.602	--	4.204
Relative Percent Difference (RPD):				*3.6%*	*3.8%*		*1.4%*
72-0120	72-0121	11/04/1997	14:24	1.301	<1.301	--	--
72-0121	72-0120	11/04/1997	14:24	**	**	--	--
Relative Percent Difference (RPD):							
72-0124	72-0125	12/09/1997	9:19	3.602	3.000	3.000	5.000
72-0125	72-0124	12/09/1997	9:19	3.079	2.845	3.079	5.000
Relative Percent Difference (RPD):				*15.7%*	*5.3%*	*2.6%*	*0.0%*
72-0160	72-0161	03/17/1998	8:41	3.342	2.732	3.017	--
72-0161	72-0160	03/17/1998	8:41	3.322	2.820	3.000	--
Relative Percent Difference (RPD):				*0.6%*	*3.1%*	*0.6%*	
72-0181	72-0182	04/22/1998	8:30	3.699	2.982	2.778	--
72-0182	72-0181	04/22/1998	8:30	3.778	3.477	2.934	--
Relative Percent Difference (RPD):				*2.1%*	*15.3%*	*5.5%*	
CHARLES RIVER, Station: CR03							
72-0034	72-0035	07/01/1997	8:40	2.342	--	**	--
72-0035	72-0034	07/01/1997	8:40	*	--	**	--
Relative Percent Difference (RPD):							
CHARLES RIVER, Station: CR00							
72-0153	72-0154	01/28/1998	11:27	3.380	3.146	3.079	2.699
72-0154	72-0153	01/28/1998	11:27	3.079	3.000	3.000	2.903
Relative Percent Difference (RPD):				*9.3%*	*4.8%*	*2.6%*	*7.3%:*
STONY BROOK, Station: ST01							
72-0023	72-0024	07/01/1997	8:56	2.079	1.301	2.146	5.602
72-0024	72-0023	07/01/1997	8:56	1.778	1.602	2.301	6.778
Relative Percent Difference (RPD):				*15.6%*	*20.7%*	*7.0%*	*19.0%*
ALDER BROOK, Station: AB01							
72-0139	72-0140	12/09/1997	10:04	2.602	2.477	2.477	**
72-0140	72-0139	12/09/1997	10:04	2.954	2.301	2.000	3.903
Relative Percent Difference (RPD):				*12.7%*	*7.4%*	*21.3%*	
72-0197	72-0198	04/22/1998	9:53	1.778	<1.301	2.146	--
72-0198	72-0197	04/22/1998	9:53	1.778	1.602	--	--
Relative Percent Difference (RPD):				*0.0%*	*20.7%*		
WABAN BROOK, Station: WB01							
72-0172	72-0177	03/17/1998	12:43	<1.301	<1.301	<1.301	--
72-0177	72-0172	03/17/1998	12:43	<1.301	<1.301	<1.301	--
Relative Percent Difference (RPD):				*0.0%*	*0.0%*	*0.0%*	
FULLER BROOK, Station: FB01							
72-0062	72-0063	07/14/1997	12:32	3.556	2.964	--	--
72-0063	72-0062	07/14/1997	12:32	3.602	2.903	--	--
Relative Percent Difference (RPD):				*1.3%*	*2.1%*		
72-0082	72-0083	08/20/1997	11:15	3.146	2.833	2.602	4.398
72-0083	72-0082	08/20/1997	11:15	3.176	2.716	**	4.362
Relative Percent Difference (RPD):				*0.9%*	*4.2%*		*0.8%*

** = missing/censored data -- = no data

Table A.2-5. 1997/1998 DEP DWM Charles River Basin Survey laboratory blank QA/QC data for organics in tissue analyses. (Data expressed in µg/g wet weight unless otherwise noted.)

ANALYTE	ACCURACY Blank #5 (6/9 - 9/29/98)	MINIMUM DETECTION LIMIT
PCB A1242	ND	0.06
PCB A1254	ND	0.17
PCB A1260	ND	0.16
Chlordane	ND	0.11
Toxaphene	ND	0.11
a-BHC	ND	0.0062
b-BHC	ND	0.0019
Lindane	ND	0.0059
d-BHC	ND	0.020
Hexachlorocyclopentadiene	ND	0.0077
Trifluralin	ND	0.0062
Hexachlorobenzene	ND	0.0091
Heptachlor	ND	0.012
Heptachlor Epoxide	ND	0.030
Methoxychlor	ND	1.07
DDD	ND	0.0052
DDE	ND	0.015
DDT	ND	0.0083
Aldrin	ND	0.0075
% Lipid	0.54	

ND - not detected or the analytical result is at or below the established minimum detection limit (MDL).

REMARKS: The samples were extracted and analyzed according to the modified AOAC 983.21 procedure for the analysis of PCBs and Organochlorine Pesticides.

Table A.2-6. 1997/1998 DEP DWM Charles River Basin Survey laboratory QA/QC data for metals in tissue analyses. (Data expressed in mg/kg wet weight unless otherwise noted.)

Sample ID	Analyte	Precision			Accuracy			Accuracy* (% Recovery)		MDL	Analytical Method
		Sample	Duplicate	RPD	LFM	Spike Amount	Recovery (%)	LFB	QCS		
97-3766	As	<MDL	<MDL	NA	1.64	1.97	83	110	95	0.040	EPA 200.9
97-3766	Pb	<MDL	<MDL	NA	1.83	1.97	93	109	106	0.140	EPA 200.7
97-3766	Se	0.172	0.101	52.0%	1.81	1.97	92	99	85	0.040	EPA 200.9
97-3766	Cd	<MDL	<MDL	NA	1.95	1.97	99	95	96	0.020	EPA 200.7
97-3769	Hg	0.17	0.15	12.5%	0.068	0.085	80	98	82	0.020	EPA 245.6

LFB - Laboratory Fortified Blank
LFM - Laboratory Fortified Matrix
MDL - Minimum Detection Limit
NA - Not Applicable
QCS - Quality Control Sample
RPD - Relative Percent Difference
*see Appendix A section A.1.2. for further details

A.3 Analytical Methods

Discrete Water Sample Analytes	EPA Method*	SM Methods**	Other Methods
Fecal Coliform		SM 9222D	
E. coli, MTEC		SM 9213D	
Enterococci		SM 9230C	
Aeromonas Hydrophilia		SM 9260L	
Alkalinity (titrimetric)	EPA 310.1	SM 2320B	
Chloride (titrimetric)		SM 4500CL-B	
Hardness (EDTA)	EPA 130.2	SM 2340B	
Turbidity	EPA 180.1	SM 2130B	
Ammonia-N (Automated – phenate)	EPA 350.1	SM 4500-NH_3-H	
Nitrate/Nitrite-N (automated – hydrazine)	EPA 353.1	SM 4500 –NO_3 -H	
Total Phosphorus	EPA 365.2	SM 4500P-E	
Suspended Solids		SM 2540D	
Fish Tissue Analytes			
PCB Arochlor 1242			AOAC 983.21***
PCB Arochlor 1254			"
PCB Arochlor 1260			"
Chlordane			"
Toxaphene			"
a-BHC			"
b-BHC			"
Lindane			"
d-BHC			"
Hexachlorocyclopentadiene			"
Trifluralin			"
Hexachlorobenzene			"
Heptachlor			"
Heptachlor Epoxide			"
Methoxychlor			"
DDD			"
DDE			"
DDT			"
Aldrin			"
Arsenic (STGFAA)	EPA 200.9	SM 3113	
Lead (ICP)	EPA 200.7	SM 3120B	
Selenium (STGFAA)	EPA 200.9	SM 3113	
Cadmium (ICP)	EPA 200.7	SM 3120B	
Mercury (cold vapor)	EPA 245.1	SM 3112B	

* = "Methods for Chemical Analysis of Water and Wastes", Environmental Protection Agency, Environmental Monitoring Systems Laboratory – Cincinnati (EMSL-CI), EPA-600/4-79-020, Revised March 1983 and 1979 where applicable.
** = Standard Methods, Examination of Water and Wastewater, 20th edition
***= PCBs and Organochlorine Pesticides in Biological Tissue, AOAC Official Methods of Analysis, 1990

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APPENDIX B – 1997/1998 DEP CHARLES RIVER WATERSHED SURVEY DATA

MATERIALS AND METHODS

The DWM began sampling in June 1997 and continued through April 1998. The DWM sampling plan matrix is summarized in Table B1. Sampling components at river stations included: stream discharge measurements, *in situ* Hydrolab™ measurements, physico-chemical and nutrient sampling, fecal coliform bacteria sampling, benthic macroinvertebrate, fish and periphyton sampling, and toxics in fish flesh. Experimental field sampling was also conducted to screen for the presence of optical brighteners. Each sampling component is described in the sections that follow.

Survey Conditions

Conditions prior to each synoptic survey were characterized by analyzing precipitation and streamflow data. Three weather station precipitation gages were used to determine precipitation and weather conditions for five days prior to and on the sampling dates: Milford Station #513, Needham Station #716, and Waltham Station #709; data for these stations were provided by the DEM Office of Water Resources (MA DEM 1998). Discharge (hereinafter referred to as streamflow) and duration data were obtained from the four continuous USGS stream gages along the Charles River (Figure B1): Medway (01103280), Dover (01103500), Wellesley (01104200), and Waltham (01104500). The data from these gages are used to calculate streamflow

Figure B1. DEP DWM stream flow and USGS gaging stations in the Charles River Watershed.

characteristics for the period of record. These statistical analyses can be found in *Water Resources Data Massachusetts and Rhode Island, Water Year 1997* (Socolow *et al.* . 1998), and 1998 provisional data (Ries 1998), and the *Gazateer of Hydrologic Characteristics of Streams in Massachusetts—Coastal River Basins of the North Shore and Massachusetts Bay* (Wandle 1984). The periods of record (POR) for the Charles River gages are as follows: Dover gage October 1937 to present, Wellesley gage August 1959 to present, and Waltham gage August 1931 to present (at the Waltham gage figures of average weekly discharge are also available for October 1903 to October 1909).

The installed gage 01103280 at Walker Street in Medway in 1997. Prior to the gage becoming operational, streamflow measurements, locations identified in Figure B1, were made on the Charles River near Walker Street in Medway during the DWM surveys (through December 1997). The gage was operational by the time of the March 1998 sampling effort.

Continuous streamflow measurements of the Charles River in Milford downstream from the Milford wastewater treatment plant discharge are also monitored under Milford Power's Limited Partnership (MPLP) Sewer Extension Permits #24633 and #133962 by ENSR Consulting and Engineering (ENSR 1992). These measurements were begun on 15 January 1992, prior to the startup of the MPLP facility. Power generation began in January 1994 while diversion of Milford WWTP effluent for cooling water at MPLP began on 1 July 1994.

In addition to gage data, streamflow was measured by DEP, DWM personnel according to standard operating procedures (TSB 1989) at 12 tributary stations and one mainstem Charles River station using a Swoffer meter (model 2100) or DEM, ORW personnel using a Price pygmy meter (Figure B1). Data reduction and stream discharge calculations were performed at either the DWM office in Worcester or at the ORW office in Boston.

To characterize survey conditions in the upper watershed, precipitation data from Milford Station #513 (MA DEM 1998) and streamflow data (ENSR 1998) were analyzed. The stream gaging station is located at the Conrail crossing just downstream of the Milford Wastewater Treatment Plant discharge. Data from the new USGS gage 01103280 were used to supplement the data in the upper Charles River Watershed (USGS 1998a). To characterize conditions in the middle portion of the watershed, data from Needham Station #716 (MA DEM 1998) and USGS Gage 01103500 at Dover (Socolow *et al.* 1998 and USGS 1998a and 1998b) were analyzed. Data from the Waltham Station #709 (MA DEM 1998) and the USGS Gage 01104500 at Waltham (Socolow *et al.* 1998, Ries 1998, and USGS 1998a and 1998b) were used to describe survey conditions in the lower Charles River Watershed.

Table B1. 1997/1998 Charles River Watershed Survey DEP DWM sampling matrix.

SEGMENT DESCRIPTIONS AND NUMBERS	STATION	1997 JUNE	1997 JULY	1997 AUG.	1997 SEP.	1997 OCT.	1997 NOV.	1997 DEC.	1998 JAN.	1998 MAR.	1998 APR.
Charles River, outlet Box Pond to outlet Populatic Pond, MA72-04	CR03	H,N,C,F	H,N,C,B, M,F,P	H,N,C,B,F		H,N,C,B,F	H,N,C,B,F	H,N,C,B,F		H,N,C,B,F	H,N,C,B,F
Mine Brook, MA72-14	MB01		F								
	MB02		M,F								
Charles River, outlet Populatic Pond to South Natick Dam, MA72-05	CR04		M,F,P								
	CR05				M						
	CR06				M						
	CR07					T					
Mill Rive,r, MA72-15	MR01		F		M						
	MR02		F		M						
Stop River, Headwaters to Norfolk-Walpole MCI discharge, MA72-09	SR01		M								
	SR02		M								
Stop River, Norfolk-Walpole MCI to confluence with Charles River, MA72-10	SR03		M,P								
Bogastow Brook, MA72-16	BB01		B	B							
	BB03		B	B							
	BB04		B,F	B,M							
	BB04A		B,F	B,M							
	BB05		B	B							
	BB06		B	B							
	BB08		B	B							
Headwater tributaries to Bogastow Brook	DP01		QM,F								
	JB01		QM								
	BB07		B								
	BB02		B								
Charles River, South Natick Dam to Chestnut St.., Needham, MA72-06	CR02	H,N,C	H,N,C,B	H,N,C,B		H,N,C,B	H,N,C,B	H,N,C,B		H,N,C,B	H,N,C,B

B= Bacteria (fecal coliform, Enterococcus, Aeromonas, *E. coli*); H= Hydrolab™ multiprobe meter (pH, dissolved oxygen, conductivity, temperature, total dissolved solids); N= Nutrients (total phosphorus, ammonia-nitrogen, nitrate-nitrogen, nitrite-nitrogen); C= Chemistry (alkalinity, hardness, chlorides, total suspended solids, turbidity); M= Macroinvertebrate sampling and habitat assessment; P= periphyton sampling; M*= Fish sampling for population assessment in addition to macroinvertebrate sampling; QM= Qualitative Macroinvertebrate Sampling (no multimetric analysis); F= Flow measurement by DEP-DWM or DEM-ORW personnel; T= Fish toxics monitoring.

Table B2. 1997/1998 Charles River Watershed Survey DEP DWM sampling matrix. (Continued.)

SEGMENT DESCRIPTIONS AND NUMBERS	STATION	1997 JUNE	1997 JULY	1997 AUG.	1997 SEP.	1997 OCT.	1997 NOV.	1997 DEC.	1998 JAN.	1998 MAR.	1998 APR.
Waban Brook, MA72-17	WB01			QM,H,N,C,B,F,P		H,N,C,B	H,N,C,B,F	H,N,C,B,F		H,N,C,B	H,N,C,B
Fuller Brook, MA72-18	FB01	H,N,C,F	H,N,C,B,F	H,N,C,B,F		H,N,C,B,F	H,N,C,B,F	H,N,C,B,F		H,N,C,B,F	H,N,C,B,F
	FB02			M,P					B		
	FB03								B		
Trout Brook, MA72-19	TB01	H,N,C,F	H,N,C,B, M*,F,P	H,N,C,B,F		H,N,C,B,F	H,N,C,B,F	H,N,C,B,F		H,N,C,B,F	H,N,C,B,F
Powissett Brook, MA72-20	PB01	H,N,C	H,N,C,B, M*,F	H,N,C,B						H,N,C,B,F	H,N,C,B,F
Charles River, Chestnut St. to Watertown Dam, MA72-07	CR01	H,N,C	H,N,C,B	H,N,C,B		H,N,C,B	H,N,C,B				
Rock Meadow Brook, MA72-21	RM01	H,N,C,F	H,N,C,B, QM,F	H,N,C,B				H,N,C,B,F		H,N,C,B,F	H,N,C,B,F
Alder Brook, MA72-22	AB01	H,N,C,F	H,N,C,B, M*,F	H,N,C,B,F		H,N,C,B,F	H,N,C,B,F	H,N,C,B,F		H,N,C,B,F	H,N,C,B,F
Sawmill Brook, MA72-23	SB01	H,N,C,F	H,N,C,B,F	H,N,C,B,F				H,N,C,B,H		H,N,C,B,F	H,N,C,B,F
	SB02								B		
	SBE1								B,H		
South Meadow Brook, MA72-24	SM01	H,N,C,F	H,N,C,B,F	H,N,C,B		H,N,C,B,F	H,N,C,B,F	H,N,C,B,F		H,N,C,B,F	H,N,C,B,F
	SM02								B		
	SME1							B,H			
Rosemary Brook, MA72-25	RB01	H,N,C,F	H,N,C,B, M*,F,P	H,N,C,B,F		H,N,C,B,F	H,N,C,B,F	H,N,C, B,F		H,N,C,B,F	H,N,C,B,F
	RBE1									B,H	
Unnamed Tributary, MA72-26	ST00							H,N,C,B		H,N,C,B,F	H,N,C,B,F
Stony Brook, MA72-27	ST01	H,N,C,F	H,N,C,B, M*,F,P	H,N,C,B,F		H,N,C,B,F	H,N,C,B,F	F			

B= Bacteria (fecal coliform, Enterococcus, Aeromonas, *E. coli*); H= Hydrolab™ multiprobe meter (pH, dissolved oxygen, conductivity, temperature, total dissolved solids); N= Nutrients (total phosphorus, ammonia-nitrogen, nitrate-nitrogen, nitrite-nitrogen); C= Chemistry (alkalinity, hardness, chlorides, total suspended solids, turbidity); M= Macroinvertebrate sampling and habitat assessment; P= periphyton sampling; M*= Fish sampling for population assessment in addition to macroinvertebrate sampling; QM= Qualitative Macroinvertebrate Sampling (no multimetric analysis); F= Flow measurement by DEP-DWM or DEM-ORW personnel; T= Fish toxics monitoring.

Table B3. 1997/1998 Charles River Watershed Survey DEP DWM sampling matrix. (Continued.)

SEGMENT DESCRIPTIONS AND NUMBERS	STATION	1997 JUNE	1997 JULY	1997 AUG.	1997 SEP.	1997 OCT.	1997 NOV.	1997 DEC.	1998 JAN.	1998 MAR.	1998 APR.
Beaver Brook, MA72-28	BE00					H,N,C,B	H,N,C,B,F	H,N,C,B,F		H,N,C,B,F	H,N,C,B,F
	BE01		H,N,C,B,F	H,N,C,B,F		F					
	BE02		M,P								
	BEE1								B,H		
	BEE2								B,H		
Cheese Cake Brook, MA72-29	CB01	H,N,C,F	H,N,C,B,F	H,N,C,B,F		H,N,C,B,F	H,N,C,B,F	H,N,C,B,F	QM	H,N,C,B,F	H,N,C,B,F
	CB02								B		
	CB05								B		
	CBE0								B,H		
	CBE1							B,H			
	CBE2								B,H		
Charles River, Watertown Dam to Science Museum Dam, MA72-08	CR00		M,P					H,N,C,B	B,H	H,N,C,B	H,N,C,B
Unnamed Tributary known as Laundry Brook MA72-30	LB01	H,N,C,F	H,N,C,B,F	H,N,C,B,F		H,N,C,B,F	H,N,C,B,F	H,N,C,B,F		H,N,C,B,F	H,N,C,B,F

B= Bacteria (fecal coliform, Enterococcus, Aeromonas, *E. coli*); H= Hydrolab™ multiprobe meter (pH, dissolved oxygen, conductivity, temperature, total dissolved solids); N= Nutrients (total phosphorus, ammonia-nitrogen, nitrate-nitrogen, nitrite-nitrogen); C= Chemistry (alkalinity, hardness, chlorides, total suspended solids, turbidity); M= Macroinvertebrate sampling and habitat assessment; P= periphyton sampling; M*= Fish sampling for population assessment in addition to macroinvertebrate sampling; QM= Qualitative Macroinvertebrate Sampling (no multimetric analysis); F= Flow measurement by DEP-DWM or DEM-ORW personnel; T= Fish toxics monitoring.

Stream Water Quality Monitoring

The DWM water quality sampling effort was comprised of two components: a baseline monitoring sampling approach complementing the IM3 Project (CRWA 1995, 1997 and 1998) and investigative sampling. Baseline surveys were conducted by DWM at three Charles River locations and 13 tributaries (Figure B2): Waban, Fuller, Trout, Powissett, Rock Meadow, Alder, Sawmill, Rosemary, Stony, Beaver, Cheese Cake and Laundry brooks. Sampling at the baseline monitoring locations included: *in situ* measurements at each station using a Scout 2 Hydrolab™ multiparameter meter (water temperature, dissolved oxygen, conductivity, total dissolved solids, and pH), physico-chemical monitoring (alkalinity, hardness, specific conductivity, chloride, total and suspended solids, and turbidity), nutrients (ammonia and nitrate nitrogen and total phosphorus) and bacteria sampling (fecal coliform, Enterococcus, Aeromonas, and *E. coli,*).

Procedures used for water sampling and sample handling are described in the *Basin Program Standard Operating Procedures* (MA DEP 1989). The Wall Experiment Station (WES), the Department's analytical laboratory, supplied all sample bottles and field preservatives, which were prepared according to the WES *Laboratory Quality Assurance Plan and Standard Operating Procedures* (MA DEP 1994). Samples were preserved in the field as necessary, transported on ice to WES, and analyzed according to the WES SOP. The quality control protocol that was followed for field and equipment blank samples is described in Appendix A of this report (*Charles River Watershed 1997/1998 Assessment Report*). Both quality control samples (field blanks, trip blanks, and split samples) and raw water quality samples were transported on ice to WES on each sampling date; they were analyzed subsequently according to the WES SOP (MA DEP 1994).

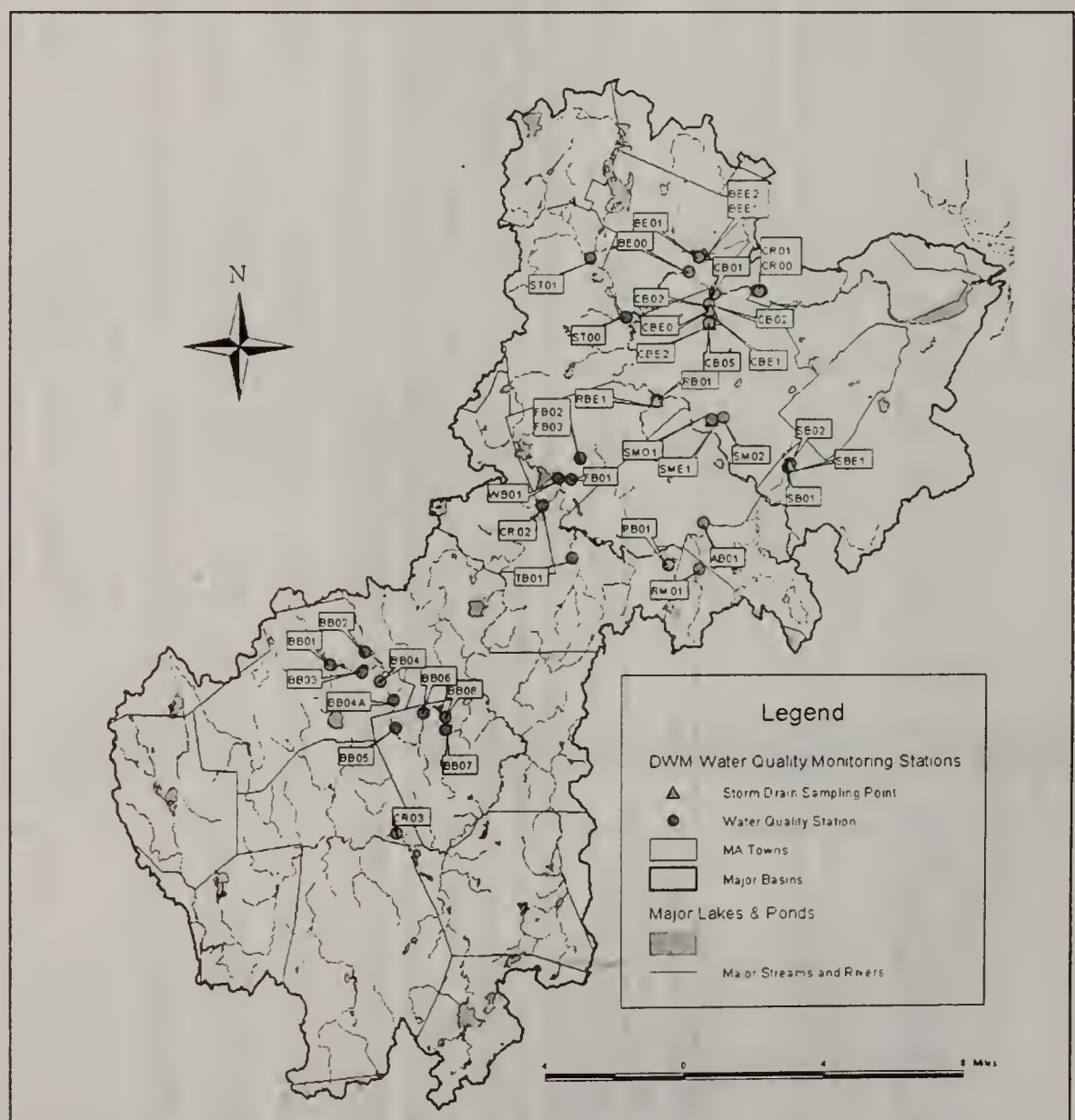

Figure B2. DEP DWM Water Quality and Storm Drain Monitoring Stations. Note: This figure does not necessarily identify all optical brightener sampling locations.

Investigative sampling to identify sources of bacteria in the Charles River tributaries included additional bacteria sampling (also included in Figure B2) and experimental screening to detect the presence of optical brighteners.

Optical Brightener Screening

Optical brighteners are found in most laundry detergents, and their presence in the water column indicates wastewater is entering the stream, via failed septic systems, illicit sewer connections, or other sources. Coupled with bacteria sampling, optical brightener sampling is a useful qualitative screening method for differentiating between human and animal sources of bacteria. While there is no actual sampling protocol, testing for optical brighteners, or whitening agents, is extremely simple.

VWR brand cotton laboratory pads are enclosed in plastic mesh and placed upright inside a galvanized wire "sandwich" framed by wood and attached to a flat concrete block. The pad/sampler is positioned so as to face into the stream current and is deployed for a week. Do to fouling, pads were replaced halfway through the index period. When retrieving pads, they are rinsed in the sample water and dried on a non-brightened surface. Once dry, pads are "read" under ultraviolet light in total darkness. If pads fluoresce under the UV light, the presence of optical brighteners is confirmed.

Optical brightener sampling was conducted in Bogastow Brook in conjunction with bacteria sampling. The historically high rate of septic system failure in the Holliston/east Holliston area is a suspected source of human bacteria inputs to the Bogastow Brook sub-basin. Sampling for the presence of optical brighteners may aid in discriminating between human and nonhuman sources (there are several large horse farms in this sub-basin as well) of bacteria. Samplers were deployed at four sites in Bogastow Brook: Lowland Street, Fiske Street, Central Street, and Middlesex Street--all in Holliston. Optical brightener samplers were also deployed in the mid/lower portion of the watershed to investigate dry weather discharges from storm drains and other contributing sources of bacteria in the more urban areas of the watershed (Cheese Cake, Rosemary, Sawmill, South Meadow, Beaver and Laundry brooks and the Charles River).

Macroinvertebrate sampling

A technical memorandum by John Fiorentino of DEP DWM entitled *Charles River Watershed Biological Monitoring* presents the aquatic macroinvertebrate analysis of samples collected from selected sites (Figure B3) in the Charles River Watershed. This memorandum is provided in Appendix C of this report (*Charles River Watershed 1997/1998 Assessment Report).*

Macroinvertebrate biomonitoring was conducted by DEP-DWM biologists based on US EPA Rapid Bioassessment Protocol III (RBP III) (Plafkin *et al.* 1989). The macroinvertebrate collection procedure utilizes kick sampling, a method of sampling benthic organisms by kicking or disturbing bottom sediments and catching the dislodged organisms downstream with an aquatic net. Where conditions are inappropriate for the collection of natural substrate samples, artificial substrates (multiplate samplers) were utilized. An integral component of the RBP III method is the assessment of available habitat quality. Physical characteristics of the stream substrate, channel morphology, and the structural stability of the stream banks were all evaluated. RBP III sampling was conducted at a total of 20 locations (Figure B3) as follows: Charles River –five locations (kick sampling at three, multiplate at two), Stop River – kick sampling at three stations, Bogastow Brook – multiplate sampling at two stations, Mill River—multiplate sampling at two stations, and kick sampling at one location each in Stony, Trout, Rosemary, Beaver, Fuller, Alder, Powissett, and Mine brooks. Qualitative sampling was conducted in five additional tributaries—Jar, Dopping, Rock Meadow, Waban and Cheese Cake brooks also shown in Figure B3.

Fish population and periphyton sampling

DEP-DWM biologists conducted fish sampling, via backpack electroshocking, at five of the macroinvertebrate sampling locations: Alder, Stony, Rosemary, Powissett and Trout brooks. Methods used to assess fish populations followed a modified version of RBP Protocol V (Plafkin *et al.* 1989). A qualitative sample of the periphyton, or the attached algal assemblage, was taken by scraping and cleaning natural substrates from various habitats. This sampling was conducted where some sunlight penetrated the canopy in the vicinity of

macroinvertebrate biomonitoring locations (seven tributaries and all mainstem stations). Results are provided in a technical memorandum by John Fiorentino of DEP DWM entitled *Charles River Watershed Biological Monitoring* which is provided in Appendix C of this report (*Charles River Watershed 1997/1998 Assessment Report).*

Fish Toxics

Uniform protocols, designed to assure accuracy and prevent cross-contamination of samples, were followed for collecting, processing and shipping fish collected for fish toxics monitoring from the Charles River upstream from the South Natick Dam on 9 October 1997. Electroshocking gear was used to collect fish. Lengths and weights were measured and fish visually inspected for tumors, lesions, or other indications of stress or disease. Fish included in the sample were placed in an ice-filled cooler and brought back to the laboratory for sample processing. Sampling at Lake Pearl, Wrentham was cancelled due to a combination of equipment failure and lack of ice cover. Sampling locations for fish toxics monitoring in the Charles River Watershed between 1995 and 1997 are also indicated in Figure B3.

Fish were filleted (skin off) on glass cutting boards and prepared for freezing. All equipment used in the filleting process is rinsed in tap water to remove slime, scales, and other fluids such as blood, then re-rinsed in deionized water before (and/or after) each sample. Two to three fillets from like-sized individuals of the same species (composite sample) were wrapped together in aluminum foil or stored in a single sample container. Fillets targeted for metals analysis were placed in VWR 32-ounce high-density polyethylene (HDPE) cups with covers. The opposite fillets were wrapped in aluminum foil for % lipids, PCBs, and organochlorine pesticide analysis. Samples were tagged and frozen for subsequent delivery to WES on 10 November 1997.

Figure B3. DEP DWM Benthic Macroinvertebrate and Fish Contamination Monitoring Stations.

Methods used at WES for analyzing metals include the cold vapor method using a VGA hydride generator for mercury and Varian 1475 flame atomic absorption for all remaining metals (MA DEP 1994). PCB/organochlorine pesticide analyses are performed on a gas chromatograph equipped with an electron capture detector.

Lakes

Synoptic surveys were conducted on 41 lakes in the Charles River Watershed during the summer of 1997. Surveys consisted of taking observations from at least one access point on each lake (multiple access points on larger lakes). At each lake, an attempt was made to observe the entire surface area to determine the extent of areal macrophyte cover.

At each observation site the general water quality was noted and all aquatic and wetland macrophyte species were recorded along with their general abundance and an estimate of the total percent areal coverage of all species. Qualitative macrophyte observations were aided by conducting several hauls with a plant "rake," which was constructed by bolting two garden rakes back-to-back, the handles cut to about half length, and then attached to about a 50' length of rope. Each time the rake was thrown to its maximum extension and then retrieved along the lake bottom. The rake was thrown several times in different directions from the observation site to provide more thorough coverage.

Where possible, transparency was measured using a standard 20 cm diameter Secchi disk attached to a rope with metric calibrations. When Secchi disk measurements were not feasible, transparency was estimated as being above or below 1.2 meters (based on the 4 foot Secchi disk bathing beach standard).

All observations were recorded on standard field sheets. Assessments of trophic status and use impairment were made on site. Later, the assessments and supporting information were entered into the US EPA Water Body System database. Data on the presence of non-native plants were entered into a separate database intended for linking to the Massachusetts Geographic Information System (MassGIS).

Baseline surveys were conducted by DEM on four Charles River ponds/lakes: Box Pond, Bellingham; Cedar Swamp Pond, Milford; Lake Louisa, Milford and Kingsbury Pond, Norfolk.

RESULTS

Survey Conditions

To fulfill the assessment guidance, information on precipitation (MA DEM 1998) and stream discharge (Socolow *et al.* 1998, Ries 1998, and USGS 1998a and 1998b, Table B2) were analyzed to determine hydrologic conditions during the water quality sampling events. This review was conducted to determine the streamflow condition in relation to the 7-day, 10-year (7Q10) low flow. Additionally, this review was used to determine whether the fecal coliform bacteria data were representative of "wet" or "dry weather" sampling conditions. Survey conditions are described below for each DWM sampling event reviewed for the assessment (MA DEP 1997a).

17 June 1997—In the upper watershed, 0.22 inches of precipitation were recorded three days prior to the sampling event. The Charles River flow measurements in Milford ranged between 3.9 and 4.1cfs during the five days preceding the survey. Streamflow on the day of the survey was slightly lower at 3.7cfs. A small amount of precipitation (0.31 inches) was measured at the Needham station four to five days prior to the sampling event. This resulted in a slight increase (2 cfs) in streamflow at the Charles River at the USGS Dover gage on the fourth day prior to the survey. However, the mean daily discharge decreased steadily from a high of 96cfs to 77cfs on the day of the survey. The highest amount of precipitation was recorded in the lower Charles River Watershed (Waltham station #709). Four days prior to the water quality survey, over one inch of rain fell resulting in an increase in streamflow at the Waltham gage from 120 to a high of 171cfs three days prior to the survey. On the day of sampling, streamflow had fallen to 77cfs, the same as was recorded at the Dover gage. The highly urbanized nature of the lower Charles River Watershed results in rapid runoff with streamflow conditions returning to pre-storm conditions within a short time span. Data from this sampling event are interpreted as representative of fairly dry weather conditions.

Streamflow characteristics (cfs) of the Charles River in June 1997:

Gaging Stations	Survey	Mean	POR * Mean
Milford @ MPLP	3.7	5.1	13.5
Dover 01103500	77	101	228
Waltham 01104500	77	129	230

* POR = period of record

1 July 1997—In the upper watershed, 0.02 inches of rain was recorded four days prior to the survey. There was no perceptible change in streamflow that hovered just above 3cfs for the five days prior to the survey. Although at the Needham station 0.02 inches of precipitation were recorded on 1 July, this small precipitation event occurred after the water quality sampling. Streamflow in the Charles River at the Dover gage decreased steadily over the five days prior to the survey (from 63 to 39cfs). No precipitation was recorded at the Waltham station within the five days prior to the survey. Streamflow in the Charles River at the Waltham gage dropped from 79cfs 48 hours prior to the survey to 52cfs on 1 July. The bacteria data from this sampling event will be interpreted as dry weather conditions.

14 July 1997—At all three weather stations, precipitation was recorded five days prior to the survey with the highest amount measured in the upper watershed (0.22 inches). Just under a tenth of an inch of rain was measured at the Needham station, while just over a tenth of an inch of rain (0.12 inches) was reported at the Waltham station. Flow in the middle and lower Charles River was somewhat lower than had been measured earlier in the month (3.3cfs in Milford, 24cfs at the Dover gage, and 39cfs at the Waltham gage). Data from this survey will be interpreted as representative of dry weather conditions.

Streamflow characteristics (cfs) of the Charles River in July 1997:

Gaging Stations	Survey	Mean	POR Mean
Milford @ MPLP	3.3	3.6	10.4
Dover 01103500	24	22.9	123
Waltham 01104500	39	34.7	126

19 August 1997—A bacteria survey of the Bogastow Brook system was conducted after a storm of moderate intensity had passed over the mid and upper watershed. Over a half an inch of rain fell between 24 and 48 hours prior to the sampling event (measured at both the Milford and Needham stations). As illustrated in Figure B4, response of the Charles River to this storm was evident at both the Milford gaging station (increase in streamflow from 3.4 to 5.2cfs 24 hours prior to sampling) and at the Dover gaging station with an increase from 26 to 36cfs 24 hours prior to sampling. Data from the Bogastow Brook subwatershed for this sampling event will be interpreted as wet weather conditions.

20 August 1997—Survey conditions were quite similar to the 19 August sampling event with the exception being that the storm occurred between 48 and 72 hours prior to the survey. Precipitation (0.37 inches) was recorded on 20 August at the Needham station, however it most likely occurred after the water quality survey. Streamflow conditions were essentially unchanged from the day before (Figure B4). The data collected as part of this survey will be interpreted with caution (neither wet nor dry) due to the uncertain conditions.

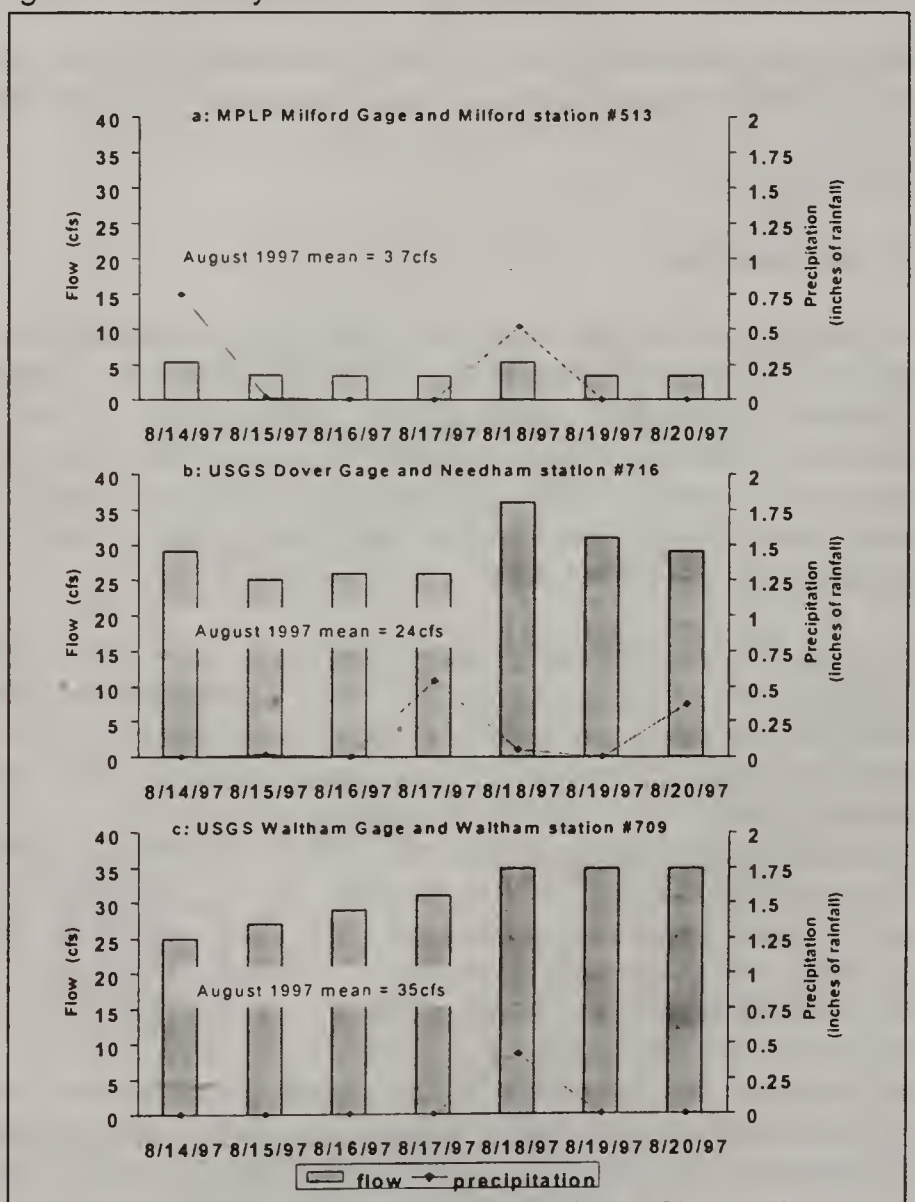
a: MPLP Milford Gage and Milford station #513
August 1997 mean = 3 7cfs
b: USGS Dover Gage and Needham station #716
August 1997 mean = 24cfs
c: USGS Waltham Gage and Waltham station #709
August 1997 mean = 35cfs
Flow (cfs)
Precipitation (inches of rainfall)
8/14/97 8/15/97 8/16/97 8/17/97 8/18/97 8/19/97 8/20/97
flow
precipitation

Figure B4:Flow and precipitation data for the Charles River during the period of 8/14/97 through 8/20/97.
a: ENSR Milford Gage and Milford station #513.
(Period of Record August mean = 10cfs)
b: USGS Dover Gage and Needham station #716.
(Period of Record August mean = 115cfs)
c: USGS Waltham Gage and Waltham station #709.
(Period of Record August mean = 117cfs)

7 October 1997—Between 48 and 96 hours prior to the 7 October sampling event, a storm covered the Charles River Watershed. Approximately one third of an inch of rain was recorded at the Milford Station in the upper watershed over a two-day period. As illustrated in Figure B5, there was an increase in streamflow from approximately 3.5 to 4.2cfs during this event after which streamflow returned back to prestorm levels. A similar response was observed at the Dover gage. Streamflow increased gradually from 16 to 24cfs and then decreased to 20cfs on the day of the survey. The most precipitation was recorded at the Waltham station (0.63 inches of rain) over a two-day period. Streamflow in the Charles River at Waltham increased from 31 to 46cfs up to the day before the survey and then dropped back to 32cfs on 7 October. The data collected are interpreted as dry weather (use caution).

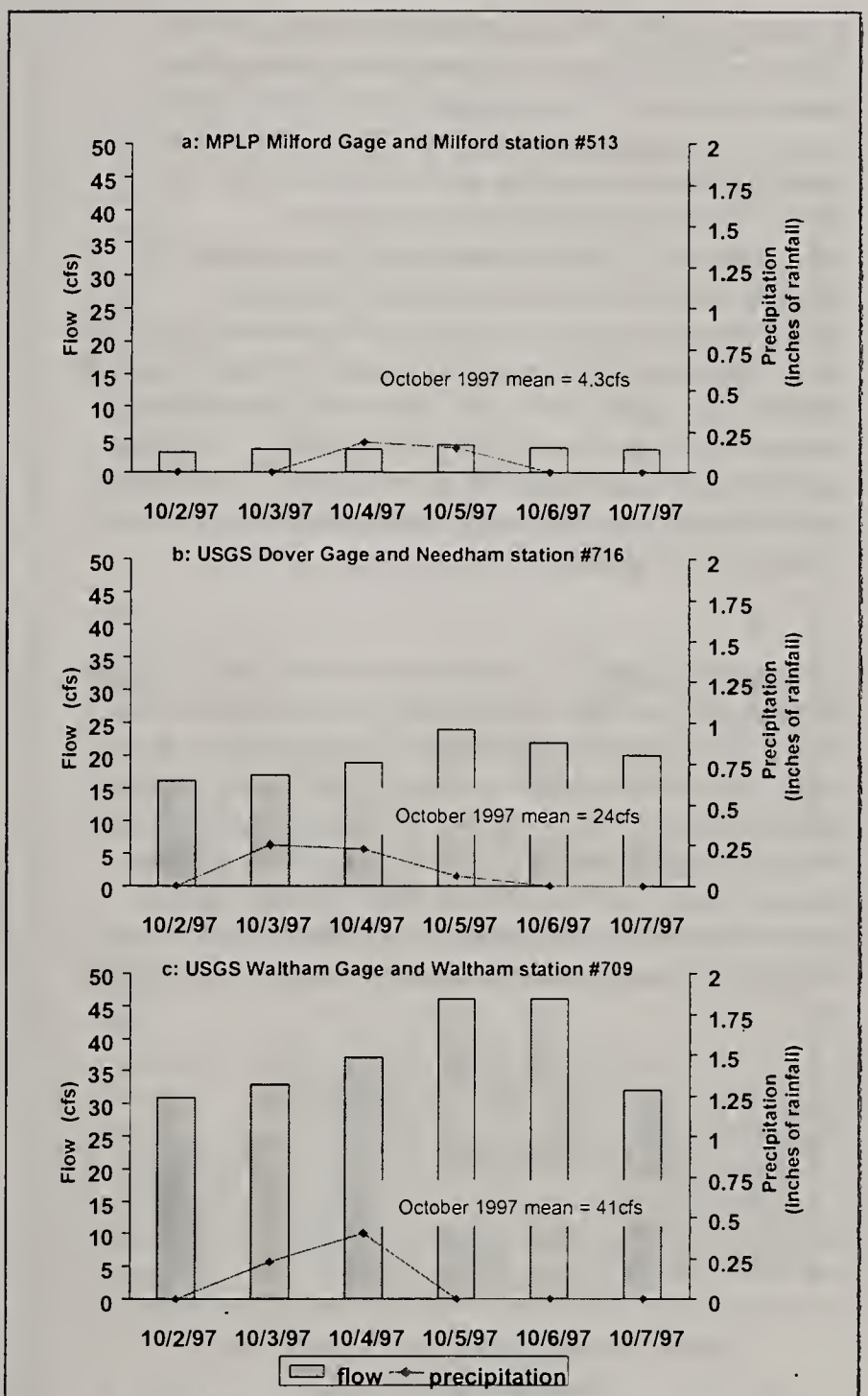
a: MPLP Milford Gage and Milford station #513
Flow (cfs)
Precipitation (Inches of rainfall)
October 1997 mean = 4.3cfs
10/2/97 10/3/97 10/4/97 10/5/97 10/6/97 10/7/97
b: USGS Dover Gage and Needham station #716
October 1997 mean = 24cfs
c: USGS Waltham Gage and Waltham station #709
October 1997 mean = 41cfs
flow
precipitation

Figure B5: Flow and precipitation data for the Charles River during the period of 10/2/97through 10/7/97.
a: ENSR Milford Gage and Milford station #513.
(Period of Record October mean = 14cfs)
b: USGS Dover Gage and Needham station #716.
(Period of Record October mean = 141cfs)
c: USGS Waltham Gage and Waltham station #709.
(Period of Record October mean = 152cfs)

4 November 1997—A cumulative average of 1.9 inches of rain fell in the Charles River Watershed between 24 and 72 hours prior to the 4 November survey. As illustrated in Figure B6, streamflow at the gages reflected response to this storm event. In Milford the Charles River increased from approximately 3.5cfs to 29cfs and then receded to approximately 5.8cfs on the day of sampling. Streamflow was still increasing at the Dover gage from 54 to 130cfs. In the lower basin, the Charles River had peaked two days prior to the survey at 280cfs and receded to 152cfs on the day of sampling. The data collected are interpreted as wet weather. Use caution particularly upper and lower watershed may be more characteristic of dry.

9 December 1997—A small storm event (<0.18 inches of rain) occured four to five days prior to the survey. There was no discernable effect on streamflow at any gage. Flow in the Charles River at the Milford gage rose slightly on the fourth day prior to the survey and then decreased steadily until the day of the survey. Streamflow at both the Dover and Waltham gages declined steadily. Data from the 9 December survey are interpreted as representing dry weather conditions.

Streamflow characteristics (cfs) of the Charles River in December 1997:

Gaging Stations	Survey	Mean	POR Mean
Milford @ MPLP	6.3	8.2	38
Dover 01103500	121	115	346
Waltham 01104500	199	187	341

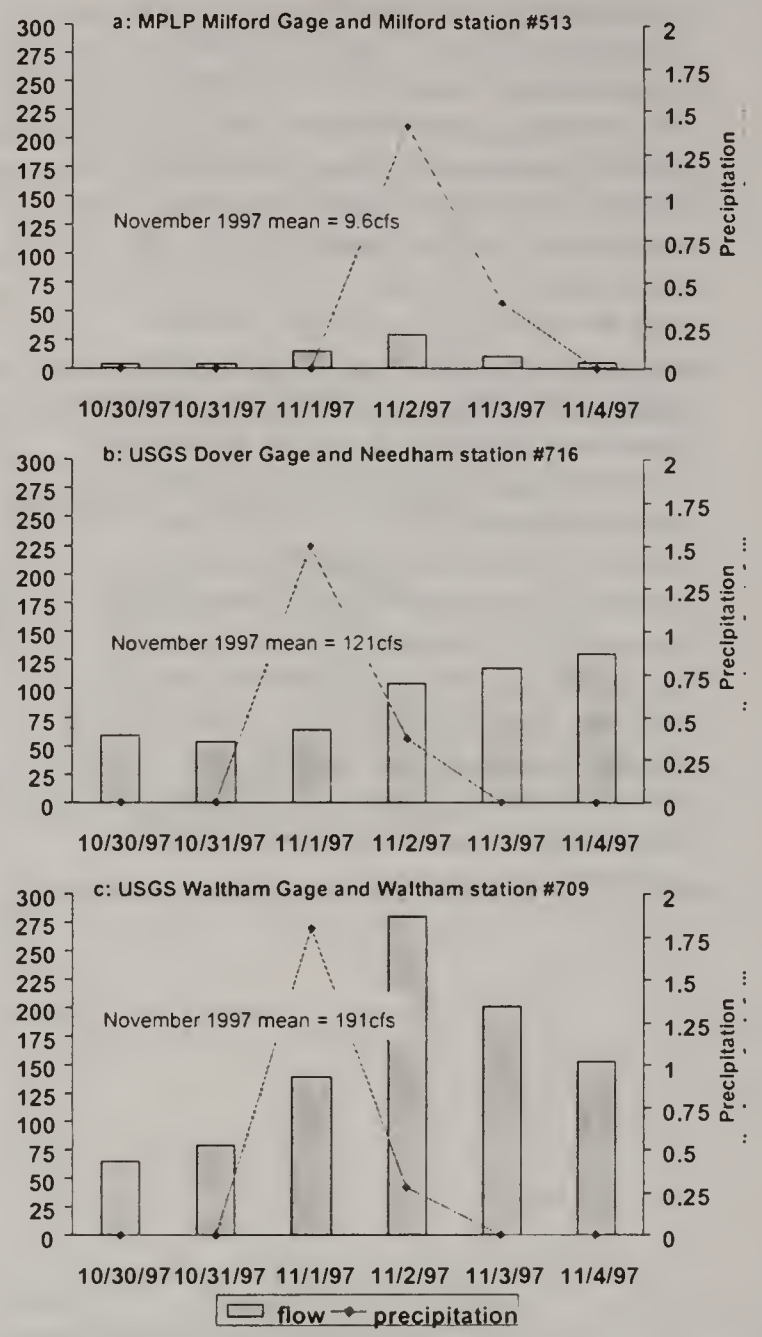
a: MPLP Milford Gage and Milford station #513
November 1997 mean = 9.6cfs
b: USGS Dover Gage and Needham station #716
November 1997 mean = 121cfs
c: USGS Waltham Gage and Waltham station #709
November 1997 mean = 191cfs
Precipitation
10/30/97 10/31/97 11/1/97 11/2/97 11/3/97 11/4/97
flow
precipitation

Figure B6: Flow and precipitation data for the Charles Rive during the period of 10/30/97 through 11/4/97.
a: ENSR Milford Gage and Milford station #513.
(Period of Record November mean = 22cfs)
b: USGS Dover Gage and Needham station #716.
(Period of Record November mean = 250cfs)
c: USGS Waltham Gage and Waltham station #709.
(Period of Record November mean = 251cfs)

28 January 1998—A major winter storm preceded the sampling event by four days. Flows in the Charles River at the Medway gage indicated an increase in discharge from an estimated 74cfs to a high of 508cfs two days prior to the survey. Flow in the Charles River at Medway then subsided to 303cfs on the day of the survey. (The mean flow at Medway was 195cfs. No Period of Record data available for this gage.) As seen in Figure B7, flow at the Dover gage, flow was still increasing (251 to 754cfs). Flow at the Waltham gage increased from 372 to 815cfs and then decreased to 751cfs on the day of the survey. However, the Mother Brook diversion was utilized to reduce peak flows in the lower Charles River. Data from the 28 January survey are interpreted as wet weather due to the intensity of the storm, although the precipitation may have been in the form of snow.

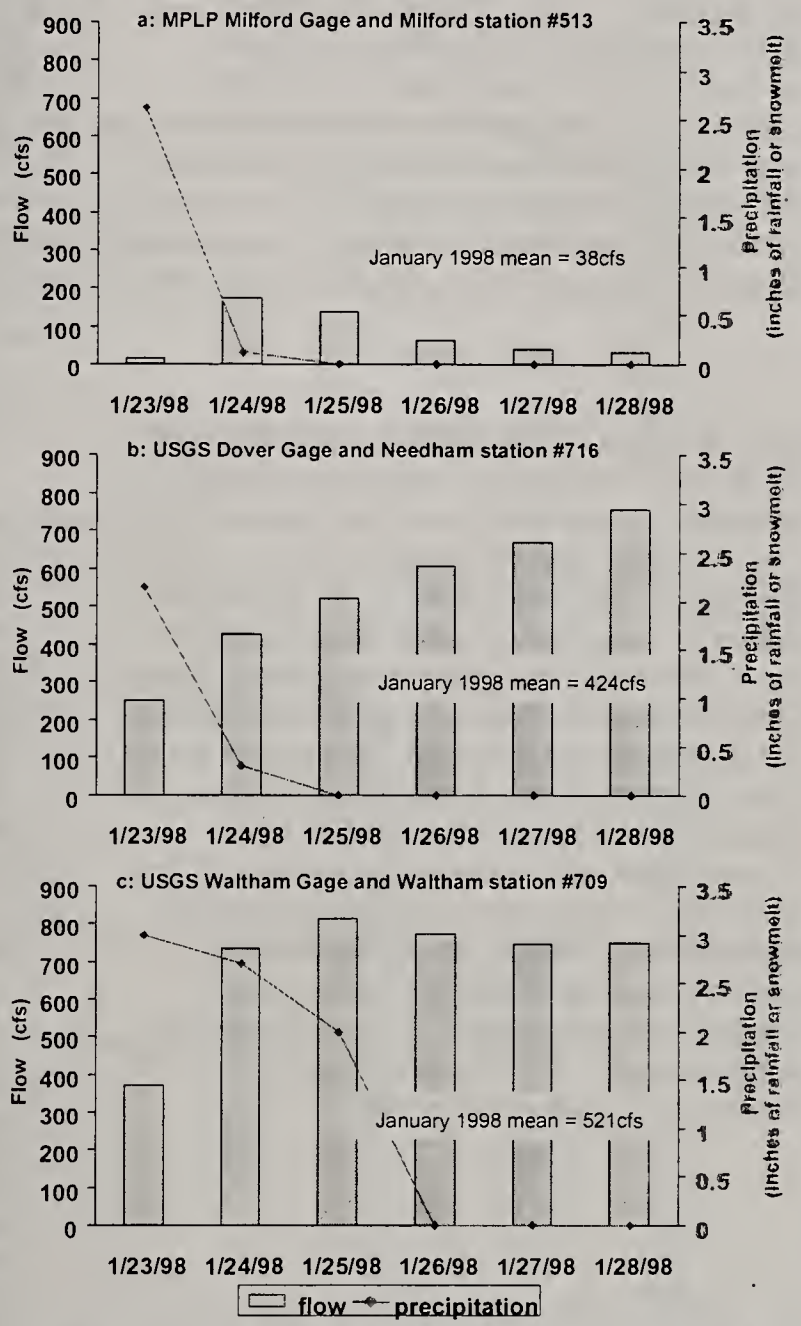
a: MPLP Milford Gage and Milford station #513
Flow (cfs)
Precipitation (inches of rainfall or snowmelt)
January 1998 mean = 38cfs
1/23/98 1/24/98 1/25/98 1/26/98 1/27/98 1/28/98
b: USGS Dover Gage and Needham station #716
January 1998 mean = 424cfs
c: USGS Waltham Gage and Waltham station #709
January 1998 mean = 521cfs
flow
precipitation

Figure B7:Flow and precipitation data for the Charles River during the period of 1/23/98 through 1/28/98.
a: ENSR Milford Gage and Milford station #513.
(Period of Record January mean = 36cfs)
b: USGS Dover Gage and Needham station #716.
(Period of Record January mean = 370cfs)
c: USGS Waltham Gage and Waltham station #709.
(Period of Record January mean = 368cfs)

17 March 1998—With the exception of 0.05 inches of precipitation recorded on one day at the Needham station, no precipitation was measured at any of the three weather stations within five days of the survey. At the Charles River Medway gage, streamflow was steadily decreasing (602 to 247cfs). Flow at the Dover gage followed the same general pattern decreasing from 1140 to 917cfs on the day of the survey. (It should be noted that a slight (6%) increase in flow was measured between four and five days prior to the survey, not considered significant). In the lower Charles River, discharge also decreased slightly (1060 to 952cfs). Data from this survey are interpreted as dry weather conditions.

Streamflow characteristics (cfs) of the Charles River in March 1998:

Gaging Stations	Survey	Mean	POR Mean
Medway 01103280	247	338	not available
Dover 01103500	917	872	618
Waltham 01104500	952	946	623

22 April 1998—A major storm event occurred two to three days prior to the survey dumping between one and one and a half inches of rain in the Charles River Watershed. The response of the Charles River, as illustrated in Figure B8, was evident at all three gages with streamflows increasing between 55 to 115cfs. Streamflow at the Waltham gage had peaked two days prior to the survey, whereas at the Dover gaging station, flows in the Charles River were still increasing. Flow in the Charles River at the Medway gage was 262cfs on the day of the survey. (The mean flow at Medway was 212cfs. No Period of Record data available for this gage.) Given the intensity of the storm and its proximity to the sampling event, the 22 April data are interpreted as wet weather data.

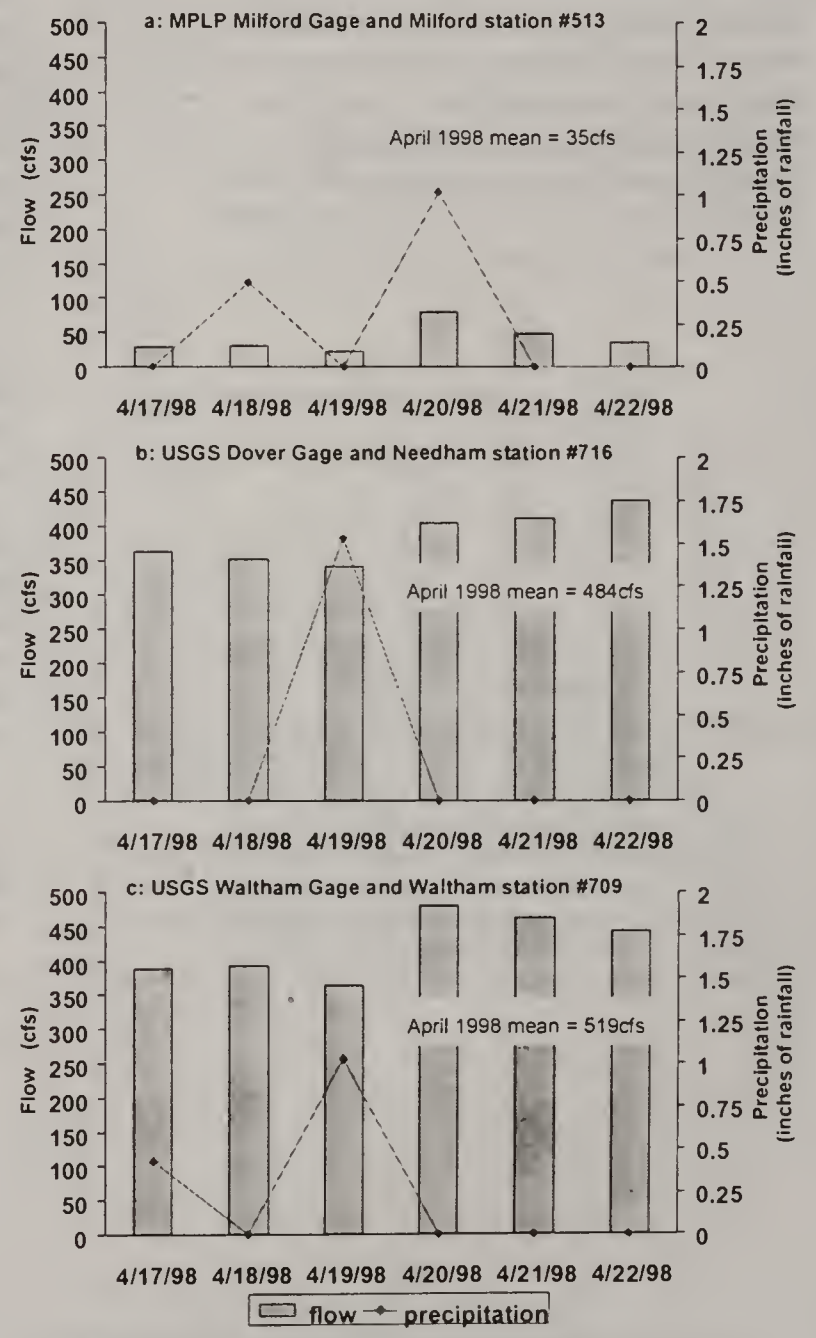
a: MPLP Milford Gage and Milford station #513
April 1998 mean = 35cfs
b: USGS Dover Gage and Needham station #716
April 1998 mean = 484cfs
c: USGS Waltham Gage and Waltham station #709
April 1998 mean = 519cfs
Flow (cfs)
Precipitation (inches of rainfall)
4/17/98 4/18/98 4/19/98 4/20/98 4/21/98 4/22/98
flow
precipitation

Figure B8:Flow and precipitation data for the Charles River during the period of 4/17/98 through 4/22/98.
a: ENSR Milford Gage and Milford station #513.
(Period of Record April mean = 41cfs)
b: USGS Dover Gage and Needham station #716.
(Period of Record April mean = 588cfs)
c: USGS Waltham Gage and Milford station #513.
(Period of Record April mean = 608cfs)

Table B2. 1997/1998 DEP DWM Charles River Watershed stream discharge measurements.

	Time (24hr)	Collecting Agency	Sampling Technique	Velocity (fps)	Discharge (cfs)
Unnamed and/or Undefined SARIS					
Station: LB01					
Description: unnamed tributary to Charles River locally known as 'Laundry Brook', Califomia Street, Watertown					
06/17/97	7:42	DEP	Swoffer 2100	0.31	0.55
07/14/97	9:40	DEM	Unknown	**	0.22 e
08/20/97	1:30	DEM	Unknown	**	0.17 e
10/07/97	1:30	DEM	Unknown	**	0.13
11/04/97	1:00	DEM	Unknown	**	0.13
12/09/97	1:00	DEM	Unknown	**	3.10
03/17/98	10:10	DEM	Unknown	**	4.31
04/21/98	2:00	DEM	Unknown	**	3.84
CHARLES RIVER					
Station: CR04					
Description: Dean Street, Millis. (between Turner Street and Myrtle Street)					
10/15/97	10:52	DEP	Swoffer 2100	**	10.2
CHARLES RIVER					
Station: CR03					
Description: Walker Street, Medway. (between Populatic Street and Canal Street)					
06/17/97	14:30	DEP	Swoffer 2100	0.59	26.1
07/08/97	2:00	DEM	Unknown	**	15.9
07/14/97	9:15	DEP	Swoffer 2100	0.66	6.86
08/20/97	11:00	DEP	Swoffer 2100	0.27	6.57
10/07/97	10:30	DEP	Swoffer 2100	0.40	8.97
11/04/97	10:30	DEP	Swoffer 2100	1.2	54.6
12/08/97	10:41	DEP	Swoffer 2100	0.92	37.7
CHEESE CAKE BROOK					
Station: CB01					
Description: Albemarle Road (at the northwestern end of Nevada Street), Newton.					
06/17/97	8:34	DEP	Swoffer 2100	0.10	0.59
07/14/97	10:15	DEM	Unknown	**	0.96
08/20/97	**	DEM	Unknown	**	0.34 e
10/07/97	2:30	DEM	Unknown	**	0.69
11/04/97	11:45	DEM	Unknown	**	1.42
12/09/97	2:00	DEM	Unknown	**	4.68
03/17/98	9:30	DEM	Unknown	**	3.29
04/21/98	1:00	DEM	Unknown	**	2.49
BEAVER BROOK					
Station: BE01					
Description: Linden Street, (Route 60), Waltham					
07/14/97	11:15	DEM	Unknown	**	0.40
08/20/97	**	DEM	Unknown	**	0.43 e
12/09/97	**	DEM	Unknown	**	4.88
03/17/98	**	DEM	Unknown	**	**
04/21/98	12:00	DEM	Unknown	**	22.0
BEAVER BROOK					
Station: BE00					
Description: culvert at southeast corner of Newton Street and River Street, Waltham					
10/07/97	12:00	DEM	Unknown	**	0.32
11/04/97	11:00	DEM	Unknown	**	10.2

** = missing/censored data e = flow estimated see field sheet for details

Table B2. 1997/1998 DEP DWM Charles River Watershed stream discharge measurements. (Continued)

	Time (24hr)	Collecting Agency	Sampling Technique	Velocity (fps)	Discharge (cfs)
STONY BROOK					
Station: ST01					
Description: Church Street, Weston. (sampled both braids and summed results)					
06/17/97	9:35	DEP	Swoffer 2100	**	7.75
07/14/97	12:00	DEM	Unknown	**	1.19
08/20/97	**	DEM	Unknown	**	0.90 e
10/07/97	**	DEM	Unknown	**	0.31
11/04/97	10:15	DEM	Unknown	**	2.49
03/17/98	**	DEM	Unknown	**	**
Unnamed and/or Undefined SARIS					
Station: ST00					
Description: South Street, Waltham/River Road, Weston					
12/09/97	11:00	DEM	Unknown	**	1.35
04/21/98	11:00	DEM	Unknown	**	35.8
ROSEMARY BROOK					
Station: RB01					
Description: north of Barton Road, south of Route 95/128, Wellesley					
06/17/97	10:55	DEP	Swoffer 2100	0.24	1.10
07/14/97	1:30	DEM	Unknown	**	0.51
08/20/97	**	DEM	Unknown	**	0.23 e
10/07/97	10:00	DEM	Unknown	**	0.80
11/04/97	9:30	DEM	Unknown	**	6.37
12/09/97	**	DEM	Unknown	**	2.21
03/17/98	1:30	DEM	Unknown	**	8.95
04/21/98	10:00	DEM	Unknown	**	12.6
SOUTH MEADOW BROOK					
Station: SM01					
Description: west of Needham Street, Newton. (adjacent to radio tower)					
06/17/97	11:49	DEP	Swoffer 2100	0.30	0.46
07/14/97	10:00	DEP	Swoffer 2100	0.13	0.19
10/07/97	11:56	DEP	Swoffer 2100	0.31	0.11
11/04/97	12:46	DEP	Swoffer 2100	0.43	0.40
12/08/97	14:10	DEP	Swoffer 2100	0.42	0.79
03/17/98	13:00	DEP	Swoffer 2100	1.1	2.62
04/22/98	12:10	DEP	Swoffer 2100	0.89	1.75
SAWMILL BROOK					
Station: SB01					
Description: northeast of Baker Street, Boston. (in Saint Josephs Cemetery in the locality of West Roxbury)					
06/17/97	13:35	DEP	Swoffer 2100	0.31	0.56
07/14/97	11:00	DEP	Swoffer 2100	0.60	0.50
08/20/97	12:00	DEP	Swoffer 2100	0.29	0.10
12/08/97	12:35	DEP	Swoffer 2100	0.31	0.75 e
03/17/98	12:00	DEP	Swoffer 2100	0.27	2.71
04/22/98	11:22	DEP	Swoffer 2100	0.49	2.32
ALDER BROOK					
Station: AB01					
Description: South Street, Needham					
06/17/97	14:29	DEP	Swoffer 2100	0.28	0.81
07/14/97	11:45	DEP	Swoffer 2100	0.19	0.34
08/20/97	13:15	DEP	Swoffer 2100	0.08	0.16
10/07/97	8:30	DEP	Swoffer 2100	0.44	0.40
11/04/97	**	DEP	Swoffer 2100	1.4	0.64
12/09/97	10:05	DEP	Swoffer 2100	0.14	0.42
03/17/98	10:00	DEP	Swoffer 2100	**	2.99
04/22/98	9:40	Swoffer 2100	**	1.79	

** = missing/censored data e = flow estimated see field sheet for details

Table B2. 1997/1998 DEP DWM Charles River Watershed stream discharge measurements. (Continued)

	Time (24hr)	Collecting Agency	Sampling Technique	Velocity (fps)	Discharge (cfs)
ROCK MEADOW BROOK					
Station: RM01					
Description: Summer Street, Westwood					
06/17/97	9:00	DEP	Swoffer 2100	0.40	0.67
07/14/97	**	DEP	Cylinder & Stopwatch	**	0.00 e
12/08/97	11:10	DEP	Swoffer 2100	0.18	0.96 e
03/17/98	10:41	DEP	Swoffer 2100	0.73	7.13
04/22/98	10:10	DEP	Swoffer 2100	0.74	3.64
POWISSETT BROOK					
Station: PB01					
Description: Wilsondale Street, Dover					
06/17/97	10:30	DEP	---------- *Not enough flow to measure*----------		
07/14/97	**	DEP	Baggie & Stopwatch	**	0.03
03/17/98	15:40	DEP	Swoffer 2100	1.6	5.27
04/22/98	14:10	DEP	Unknown	0.84	2.32
TROUT BROOK					
Station: TB01					
Description: Haven Street, Dover					
06/17/97	11:10	DEP	Swoffer 2100	0.38	2.77
07/14/97	11:02	DEP	Swoffer 2100	0.15	1.21
08/20/97	3:40	DEP	Swoffer 2100	0.07	0.45
10/07/97	10:00	DEP	Swoffer 2100	0.47	0.85
11/04/97	10:41	DEP	Swoffer 2100	0.75	1.63
12/09/97	12:45	DEP	Swoffer 2100	0.18	1.21
03/17/98	14:05	DEP	Swoffer 2100	1.2	11.5
04/22/98	1:04	DEP	Swoffer 2100	1.0	11.0
WABAN BROOK					
Station: WB01					
Description: southwest off Service Drive, Wellesley					
08/20/97	14:15	DEP	Swoffer 2100	0.09	0.41
10/07/97	12:33	DEP	---------- *Not enough flow to measure*----------		
11/04/97	13:20	DEP	Swoffer 2100	0.19	0.22
12/08/97	2:25	DEP	Swoffer 2100	0.59	6.72
03/17/98	11:12	DEP	Swoffer 2100	0.64	37.9
04/22/98	10:45	DEP	Swoffer 2100	0.65	16.4
FULLER BROOK					
Station: FB01					
Description: Dover Road, Wellesley					
06/17/97	12:10	DEP	Swoffer 2100	0.64	1.85
07/14/97	12:45	DEP	Swoffer 2100	0.45	0.71
08/20/97	12:25	DEP	Swoffer 2100	0.48	0.71
10/07/97	1:27	DEP	Swoffer 2100	0.38	0.70
11/04/97	14:00	DEP	Swoffer 2100	0.71	1.56
12/08/97	13:40	DEP	Swoffer 2100	1.3	3.34
03/17/98	12:35	DEP	Swoffer 2100	1.6	12.5
04/22/98	11:42	DEP	Swoffer 2100	1.6	9.28

** = missing/censored data e = flow estimated see field sheet for details

Stream Water Quality Monitoring

All DEP water quality data is managed and maintained in an Access Database (Dallaire 1999b). The Hydrolab *in-situ* results are provided in Table B3. Discrete water sampling data includes physico-chemical (Table B4), bacterial data (Table B5) and optical brightener screening data (Table B6). One additional goal of the 1997/1998 Charles River Watershed survey was to investigate and ultimately derive an estimate of annual nonpoint source loadings to the mainstem Charles River between the South Natick Dam in Natick and the Watertown Dam in Watertown. Nutrient and flow monitoring was conducted monthly during the

1997/1998 DEP Charles River Watershed survey. Loading calculations are not presented in this assessment report, however the flow and nutrient data are available for these calculations in Table B2 and B4, respectively.

Table B3. 1997/1998 DEP DWM Charles River Watershed, *in-situ* Hydrolab data.

		Time (24hr)	Measurement Depth (m)	Temp (°C)	pH (SU)	Cond (uS/cm)	TDS (g/l)	DO (mg/l)	SAT (%)	Turb (NTU)
Unnamed and/or Undefined SARIS										
Station: ST00, Mile Point: 0.1										
Description: 30 feet downstream/east of South Street/River Street below outlet Stony Brook Reservoir, Waltham/Weston.										
72-0129	12/09/97	10:58	<0.3	3.3	7.1	375	0.2	10.7	79	--
72-0165	03/17/98	10:35	0.4	4.1	6.6	204	0.1	13.2	98	**
70-0186	04/22/98	09:35	0.3	12.9	7.4	293	0.2	3.1	29	**
Unnamed and/or Undefined SARIS										
Station: BB07, Mile Point: 0.1										
Description: downstream/east side at Exchange Street, Millis. (unnamed tributary to Bogastow Brook)										
72-0042	07/01/97		---------- *Not enough flow to take sample*----------							
Unnamed and/or Undefined SARIS										
Station: LB01, Mile Point: 0.01										
Description: 10 feet downstream/north of California Street, Watertown. Unnamed tributary locally known as Laundry Brook.										
72-0002	06/17/97	08:18	<0.3	17.2	7.3	379	0.2	8.7	89	--
72-0047	07/14/97	09:10	<0.3	18.5	7.5	492	0.3	8.2	86	--
72-0066	08/20/97	09:03	<0.3	18.8	7.7	413	0.3	7.6	80	19
72-0105	10/07/97	13:19	0.4	15.8	7.6	328	0.2	9.0	89	--
72-0120	11/04/97	14:23	0.3	12.9	7.6	287	0.2	10.1	94	--
72-0124	12/09/97	09:09	<0.3	4.1	7.3	335	0.2	13.1	98	--
72-0160	03/17/98	08:41	0.4	4.5	6.8	461	0.3	12.8	96	**
72-0181	04/22/98	08:30	0.1	11.6	7.2	401	0.3	10.1	91	**
CHARLES RIVER										
Station: CR03, Mile Point: 41										
Description: upstream/west at Walker Street, Medway.										
72-0012	06/17/97	09:55	0.4	21.1	7.2	313	0.2	8.4	93	--
72-0058	07/14/97	09:32	<0.3	23.8	7.5	526	0.3	7.7	90	2
72-0077	08/20/97	08:49	0.3	20.2	7.5	516	0.3	8.1	88	--
72-0093	10/07/97	08:04	0.3	13.5	7.3	518	0.3	9.6	90	--
72-0108	11/04/97	08:05	0.4	10.4	6.8	391	0.3	10.2	90	--
72-0133	12/09/97	08:37	<0.3	0.43	6.2	340	0.2	13.8	93	8
72-0169	03/17/98	09:10	0.7	2.2	6.2	209	0.1	13.9	98	--
70-0190	04/22/98	08:42	0.1	11.7	6.4	217	0.1	10.0	90	--
CHARLES RIVER										
Station: CR02, Mile Point: 19.9										
Description: upstream/south at unnamed street which is due northeast of Schaller Street, Wellesley/Dover.										
72-0011	06/17/97	13:11	0.9	23.4	7.2	267	0.2	8.8	102	--
72-0057	07/14/97	11:30	0.5	25.4	7.2	347	0.2	6.6	80	5
72-0076	08/20/97	11:48	0.9	22.7	7.5	390	0.3	7.1	81	--
72-0094	10/07/97	09:01	0.5	15.0	7.1	387	0.2	7.2	70	--
72-0109	11/04/97	09:15	0.9	10.7	6.9	359	0.2	8.9	79	--
72-0134	12/09/97	12:25	<0.3	1.6	6.4	293	0.2	12.9	91	2
72-0170	03/17/98	13:04	0.6	3.6	6.4	176	0.1	13.2	96	--
72-0191	04/22/99	12:04	0.6	13.4	6.3	216	0.1	9.6	89	--
CHARLES RIVER										
Station: CR00, Mile Point: 8.9										
Description: approximately 100 feet downstream/east of Watertown Dam, Watertown.										
72-0123	12/09/97	09:00	0.8	2.2	7.0	356	0.2	13.0	93	--
72-0153	01/28/98	11:27	0.3	1.2	6.8	439	0.3	13.8	94	--
72-0159	03/17/98	08:29	0.8	3.0	6.4	229	0.1	13.6	98	**
72-0180	04/22/98	08:20	0.6	13.0	7.0	295	0.2	9.9	92	**

* = outside calibrated range, ** = censored data, -- = no data

Table B3. 1997/1998 DEP DWM Charles River Watershed, *in-situ* Hydrolab data. (Continued)

		Time (24hr)	Measurement Depth (m)	Temp (°C)	pH (SU)	Cond (uS/cm)	TDS (g/l)	DO (mg/l)	SAT (%)	Turb (NTU)
Pipe/Discharge to CHEESE CAKE BROOK										
Station: CBE0, Mile Point: 0.6										
Description: pipe adjacent to Albemarle Park swimming pool approximately 100 meters upstream/south of Crafts Street, Newton.										
72-0149	01/28/98	10:41	<0.3	9.3	6.7	733	0.5	10.6	90	--
CHEESE CAKE BROOK										
Station: CB01, Mile Point: 0.01										
Description: at mouth appproximately 10 meters upstream of confluence, Newton.										
72-0004	06/17/97	09:06	<0.3	16.5	6.7	701	0.4	9.5	96	--
72-0049	07/14/97	09:30	<0.3	20.0	7.0	667	0.4	9.6	104	--
72-0068	08/20/97	09:26	<0.3	16.2	6.8	666	0.4	9.9	99	**
72-0103	10/07/97	12:30	0.3	17.3	7.3	714	0.5	13.0	133	--
72-0118	11/04/97	13:53	0.7	13.1	6.6	518	0.3	5.8	55	--
72-0127	12/09/97	09:40	<0.3	3.5	7.0	260	0.2	12.6	93	--
72-0163	03/17/98	09:14	0.6	5.6	6.4	640	0.4	12.4	96	1
72-0183	04/22/98	08:51	0.4	9.5	6.7	664	0.4	11.1	95	0.5
Pipe/Discharge to BEAVER BROOK										
Station: BEE2, Mile Point: 0.61										
Description: from stormdrain pipe upstream/east at Route 60, Waltham. (upstream/east of Lyman Pond)										
72-0156	01/28/98	07:52	0.4	0.88	6.6	853	0.5	12.1	82	--
Pipe/Discharge to BEAVER BROOK										
Station: BEE1, Mile Point: 0.6										
Description: from stormdrain pipe downstream/west at Route 60 (upstream/east of Lyman Pond), Waltham.										
72-0155	01/28/98	07:44	0.5	0.91	6.5	853	0.5	12.2	83	--
BEAVER BROOK										
Station: BE01, Mile Point: 0.4										
Description: upstream/north side at Route 60 (downstream/south of Lyman Pond), Waltham.										
72-0050	07/14/97	09:48	<0.3	22.0	6.9	605	0.4	2.0	22	--
72-0069	08/20/97	09:54	<0.3	18.6	6.8	382	0.2	3.3	35	6
BEAVER BROOK										
Station: BE00, Mile Point: 0.01										
Description: approximately 100 feet downstream/south of River Street from culvert in parking lot (convenience/appliance store), Waltham.										
72-0102	10/07/97	12:11	0.3	15.0	7.0	432	0.3	6.2	60	--
72-0117	11/04/97	13:34	0.4	11.4	6.7	365	0.2	8.1	73	--
72-0128	12/09/97	10:23	<0.3	2.7	7.0	613	0.4	12.3	89	--
72-0164	03/17/98	10:03	0.6	3.0	6.5	532	0.3	12.2	88	2
72-0185	04/22/98	09:11	0.3	10.8	6.9	486	0.3	8.8	78	4.4
STONY BROOK										
Station: ST01, Mile Point: 0.1										
Description: upstream/northwest at Church Street, Weston.										
72-0005	06/17/97	09:38	<0.3	17.3	7.0	171	0.1	8.2	84	--
72-0051	07/14/97	10:09	<0.3	20.5	7.1	222	0.1	7.9	86	--
72-0070	08/20/97	10:19	<0.3	16.7	7.3	214	0.1	8.4	85	**
72-0101	10/07/97	11:15	0.3	13.1	7.2	223	0.1	9.4	88	--
72-0116	11/04/97	12:07	0.4	9.6	6.7	247	0.2	9.0	77	--
Pipe/Discharge to ROSEMARY BROOK										
Station: RBE1, Mile Point: 0.11										
Description: approximately 65 meters downstream/north of Barton Road. (Pipe enters Rosemary Brook from eastern bank approximately 10 meters upstream/south of station RB01.)										
72-0179	03/17/98	11:14	**	**	**	**	**	**	**	**

* = outside calibrated range, ** = censored data, -- = no data

Table B3. 1997/1998 DEP DWM Charles River Watershed, *in-situ* Hydrolab data. (Continued)

		Time (24hr)	Measurement Depth (m)	Temp (°C)	pH (SU)	Cond (uS/cm)	TDS (g/l)	DO (mg/l)	SAT (%)	Turb (NTU)
ROSEMARY BROOK										
Station: RB01, Mile Point: 0.1										
Description: approximately 75 meters downstream/north of Barton Road, Wellesley.										
72-0006	06/17/97	10:11	<0.3	20.3	6.8	416	0.3	3.9	42	--
72-0052	07/14/97	10:32	<0.3	22.3	6.9	496	0.3	4.1	47	--
72-0071	08/20/97	10:52	<0.3	17.3	6.7	502	0.3	5.2	53	**
72-0100	10/07/97	10:48	0.3	14.3	6.9	468	0.3	7.2	68	--
72-0115	11/04/97	11:39	0.4	11.8	6.8	327	0.2	8.3	75	--
72-0130	12/09/97	11:22	<0.3	2.6	6.9	399	0.3	12.1	87	--
72-0166	03/17/98	11:04	0.5	5.4	6.4	320	0.2	13.1	100	4
72-0187	04/22/98	10:00	0.2	12.6	7.0	350	0.2	9.8	90	5.9
Pipe/Discharge to SOUTH MEADOW BROOK										
Station: SME1, Mile Point: 0.41										
Description: stormdrain pipe approximately 3 meters upstream/east of SM01, Newton.										
72-0143	12/09/97	11:55	**	**	**	**	**	**	**	--
SOUTH MEADOW BROOK										
Station: SM01, Mile Point: 0.4										
Description: approximately 100 meters downstream/west of Needham Street, Newton.										
72-0007	06/17/97	10:49	<0.3	15.5	6.8	762	0.5	5.3	53	--
72-0053	07/14/97	10:56	<0.3	19.4	6.8	807*	0.5	3.6	39	--
72-0072	08/20/97	11:36	<0.3	16.7	6.7	732	0.5	4.3	43	**
72-0099	10/07/97	10:24	0.3	14.4	6.8	799	0.5	3.6	35	--
72-0114	11/04/97	11:07	0.3	10.7	6.9	530	0.3	7.4	66	--
72-0131	12/09/97	11:47	<0.3	3.8	7.0	688	0.4	10.7	80	--
72-0167	03/17/98	11:46	0.3	6.5	6.6	620	0.4	11.9	94	**
72-0188	04/22/98	10:51	0.2	10.7	6.9	640	0.4	9.9	88	**
Pipe/Discharge to SAWMILL BROOK										
Station: SBE1, Mile Point: 1.29										
Description: stormdrain pipe approximately 100 to 200 meters upstream/northeast of Baker Street, Boston										
72-0147	01/28/98	09:48	<0.3	8.0	6.5	**	**	6.2	50	--
SAWMILL BROOK										
Station: SB01, Mile Point: 1.1										
Description: approximately 10 meters upstream/northeast of Baker Street, Boston. (approximately 1 meter upstream of the foot bridge)										
72-0008	06/17/97	11:23	<0.3	14.8	6.7	860*	0.6	3.3	33	--
72-0054	07/14/97	11:21	<0.3	16.3	6.5	849*	0.5	3.1	31	--
72-0073	08/20/97	12:09	<0.3	16.8	6.5	454	0.3	<1.0	7	8
72-0132	12/09/97	12:21	<0.3	4.8	6.8	819*	0.5	7.4	57	--
72-0168	03/17/98	12:21	0.5	6.1	6.5	604	0.4	11.1	87	**
72-0189	04/22/98	11:18	0.3	10.0	6.8	635	0.4	9.7	85	**
ALDER BROOK										
Station: AB01, Mile Point: 0.1										
Description: approximately 5 meters downstream/southeast of South Street, Needham.										
72-0009	06/17/97	11:48	<0.3	19.7	7.2	422	0.3	7.6	82	--
72-0055	07/14/97	11:43	<0.3	22.3	7.0	414	0.3	6.2	70	--
72-0074	08/20/97	12:39	<0.3	19.2	7.2	382	0.2	7.9	83	**
72-0098	10/07/97	09:55	0.4	13.9	7.0	361	0.2	8.1	77	--
72-0113	11/04/97	10:44	0.3	10.9	6.8	335	0.2	8.1	72	--
72-0139	12/09/97	10:04	<0.3	2.5	6.4	405	0.3	12.5	90	6
72-0176	03/17/98	11:15	<0.3	5.4	6.7	372	0.2	12.9	98	--
72-0197	04/22/98	09:53	<0.3	11.7	6.7	387	0.2	10.3	93	--

* = outside calibrated range, ** = censored data, -- = no data

Table B3. 1997/1998 DEP DWM Charles River Watershed, *in-situ* Hydrolab data. (Continued)

		Time (24hr)	Measurement Depth (m)	Temp (°C)	pH (SU)	Cond (uS/cm)	TDS (g/l)	DO (mg/l)	SAT (%)	Turb (NTU)
ROCK MEADOW BROOK										
Station: RM01, Mile Point: 1.1										
Description: upstream/southwest at Summer Street, Westwood.										
72-0013	06/17/97	11:04	<0.3	20.6	6.9	373	0.2	7.2	79	--
72-0059	07/14/97	10:15	<0.3	19.7	6.9	346	0.2	6.6	71	5
72-0078	08/20/97	09:38	0.3	15.5	7.0	373	0.2	8.2	81	--
72-0138	12/09/97	09:43	<0.3	1.8	6.0	424	0.3	13.0	91	7
72-0175	03/17/98	10:48	0.3	4.4	6.5	278	0.2	12.9	96	--
72-0196	04/22/98	10:16	<0.4	12.7	6.7	340	0.2	10.2	95	--
POWISSETT BROOK										
Station: PB01, Mile Point: 0.6										
Description: downstream/north at Wilsondale Street, Dover.										
72-0014	06/17/97	11:41	<0.3	22.1	5.9	71	0.04	4.6	52	--
72-0060	07/14/97	10:35	<0.3	24.1	6.1	78	0.05	1.1	13	2
72-0079	08/20/97		---------- *Not enough flow to take sample*----------							
72-0174	03/17/98	10:29	0.3	3.5	5.3	68	0.04	12.6	91	--
72-0195	04/22/98	10:34	0.1	12.7	5.5	64	0.04	10.9	100	--
TROUT BROOK										
Station: TB01, Mile Point: 1										
Description: approximately 5 meters downstream/north of Haven Street, Dover.										
72-0015	06/17/97	12:33	<0.3	13.7	6.3	219	0.1	9.6	91	--
72-0061	07/14/97	11:05	<0.3	15.3	6.3	236	0.2	8.8	87	**
72-0080	08/20/97	10:24	0.4	13.6	6.6	227	0.1	9.3	88	--
72-0097	10/07/97	08:45	0.4	12.5	6.4	215	0.1	6.0	55	--
72-0112	11/04/97	08:53	0.4	7.8	6.1	262	0.2	7.4	61	--
72-0137	12/09/97	09:20	**	**	**	**	**	**	**	**
72-0171	03/17/98	09:50	0.7	2.0	5.8	153	0.10	12.0	84	--
72-0192	04/22/98	09:26	0.2	8.7	5.8	159	0.1	8.4	71	--
WABAN BROOK										
Station: WB01, Mile Point: 0.5										
Description: downstream/south at dirt road off of Service Drive, Wellesley.										
72-0081	08/20/97	10:56	0.3	21.3	7.1	375	0.2	6.8	75	--
72-0095	10/07/97	09:19	0.4	14.3	6.9	372	0.2	6.7	64	--
72-0110	11/04/97	10:17	0.3	10.4	6.6	338	0.2	6.1	53	--
72-0135	12/09/97	11:12	<0.3	3.0	7.2	352	0.2	13.3	97	8
72-0172	03/17/98	12:43	0.5	5.9	7.0	371	0.2	12.6	97	--
72-0193	04/22/98	11:40	0.6	14.5	6.9	364	0.2	11.1	106	--
FULLER BROOK										
Station: FB01, Mile Point: 0.3										
Description: approximately 5 meters upstream/north of Dover Street, Wellesley.										
72-0016	06/17/97	13:56	<0.3	19.1	7.2	425	0.3	9.4	101	--
72-0062	07/14/97	12:32	<0.3	22.4	7.3	493	0.3	9.0	102	3
72-0082	08/20/97	11:15	0.4	17.5	7.1	371	0.2	8.8	90	--
72-0096	10/07/97	09:33	0.5	13.6	7.0	360	0.2	8.1	76	--
72-0111	11/04/97	10:06	0.5	10.1	6.8	353	0.2	9.2	80	--
72-0136	12/09/97	10:50	<0.3	2.8	6.4	437	0.3	12.3	89	5
72-0173	03/17/98	12:19	0.5	5.9	6.3	327	0.2	12.7	98	--
72-0194	04/22/98	11:15	0.4	11.4	6.7	307	0.2	10.3	92	--

* = outside calibrated range, ** = censored data, -- = no data

Table B4. 1997 DEP DWM Charles River Watershed, instream physico/chemical data. All units in mg/L unless otherwise noted.

			Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
Unnamed and/or Undefined SARIS														
Station: ST00, Mile Point: 0.1														
Description: 30 feet downstream/east of South Street/River Street below outlet Stony Brook Reservoir, Waltham/Weston.														
72-0129		12/09/97	10:58	2.6	59	--	**	**	--	**	--	<0.02	0.25	0.02
72-0165		03/17/98	10:35	16	38	--	40	<1.0	--	2.0	--	<0.02	0.58	0.02
72-0186		04/22/98	9:35	22	48	--	64	1.8	--	1.0	--	<0.02	0.46	0.02
Unnamed and/or Undefined SARIS														
Station: LB01, Mile Point: 0.01														
Description: 10 feet downstream/north of California Street, Watertown. Unnamed tributary locally known as Laundry Brook.														
72-0002	72-0003	06/17/97	8:16	35	64	--	80	<2.5	--	--	--	0.02	1.3	**
72-0003	72-0002	06/17/97	8:16	35	65	--	78	<2.5	--	--	--	0.02	1.3	**
72-0047	72-0048	07/14/97	9:07	44	67	--	100	<2.5	--	1.0	--	0.02	2.8	0.10
72-0048	72-0047	07/14/97	9:07	45	66	--	96	<2.5	--	1.0	--	0.02	2.8	0.10
72-0066	72-0067	08/20/97	9:02	45	77	--	80	<2.5	--	6.2	--	<0.02	1.8	0.10
72-0067	72-0066	08/20/97	9:02	45	77	--	80	<2.5	--	6.7	--	<0.02	1.8	0.10
72-0105	72-0106	10/07/97	13:21	33	65	--	63	**	--	0.90	--	<0.02	1.6	0.10
72-0106	72-0105	10/07/97	13:21	32	66	--	60	**	--	0.90	--	<0.02	1.7	0.10
72-0120	72-0121	11/04/97	14:24	35	59	--	45	<2.5	--	2.2	--	<0.02	1.2	0.11
72-0121	72-0120	11/04/97	14:24	35	59	--	45	<2.5	--	2.3	--	<0.02	1.2	0.11
72-0124	72-0125	12/09/97	9:19	33	43	--	**	**	--	**	--	0.05	0.67	0.04
72-0125	72-0124	12/09/97	9:19	32	43	--	**	**	--	**	--	0.03	0.64	0.05
72-0160	72-0161	03/17/98	8:41	37	65	--	72	<1.0	--	2.1	--	0.08	1.5	0.06
72-0161	72-0160	03/17/98	8:41	38	67	--	110	1.2	--	2.0	--	0.08	1.5	0.05
72-0181	72-0182	04/22/98	8:30	32	56	--	90	2.6	--	1.6	--	0.02	0.77	0.11
72-0182	72-0181	04/22/98	8:30	33	56	--	89	2.6	--	1.5	--	0.02	0.78	0.10
CHARLES RIVER														
Station: CR03, Mile Point: 41														
Description: upstream/west at Walker Street, Medway.														
72-0012		06/17/97	9:51	31	48	--	59	4.0	--	--	--	0.04	0.89	0.07
72-0058		07/14/97	9:32	48	84	--	86	<2.5	--	1.9	--	0.03	0.76	0.05
72-0077		08/20/97	8:49	47	91	--	80	3.6	--	1.7	--	0.04	0.59	0.04
72-0093		10/07/97	8:03	47	101	--	87	**	--	2.3	--	<0.02	2.0	0.04
72-0108		11/04/97	8:01	22	81	--	55	3.8	--	1.8	--	<0.02	2.6	0.06
72-0133		12/09/97	8:35	19	59	--	**	**	--	**	--	0.03	1.1	0.03
72-0169		03/17/98	9:10	10	28	--	48	<1.0	--	1.1	--	<0.02	0.69	0.02
72-0190		04/22/98	8:42	19	27	--	45	4.0	--	1.7	--	0.03	0.52	0.05

** = missing/censored data -- = no data

Table B4. 1997 DEP DWM Charles River Watershed, instream physico/chemical data. All units in mg/L unless otherwise noted. (Continued)

		Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
CHARLES RIVER													
Station: CR02, Mile Point: 19.9													
Description: upstream/south at unnamed street which is due northeast of Schaller Street, Wellesley/Dover.													
72-0011	06/17/97	13:11	32	44	--	48	5.2	--	--	--	<0.02	0.47	0.11
72-0057	07/14/97	11:30	49	63	--	58	<2.5	--	2.0	--	<0.02	0.22	0.09
72-0076	08/20/97	11:48	56	65	--	58	2.6	--	1.3	--	<0.02	0.08	0.08
72-0094	10/07/97	9:01	50	71	--	60	**	--	0.70	--	<0.02	1.5	0.04
72-0109	11/04/97	9:14	34	70	--	60	<2.5	--	1.6	--	<0.02	0.80	0.08
72-0134	12/09/97	12:25	20	57	--	**	**	--	**	--	0.05	0.78	0.05
72-0170	03/17/98	13:04	11	26	--	34	<1.0	--	1.3	--	0.02	0.34	0.02
72-0191	04/22/98	12:04	20	34	--	47	4.4	--	1.7	--	0.08	0.52	0.04
CHARLES RIVER													
Station: CR01, Mile Point: 9													
Description: sampled from the upstream/west side of footbridge above Watertown Dam, Watertown.													
72-0001	06/17/97	8:44	35	54	--	66	3.0	--	--	--	0.13	0.51	0.07
72-0046	07/14/97	9:00	44	73	--	78	<2.5	--	1.1	--	0.04	0.22	0.05
72-0065	08/20/97	8:40	47	71	--	90	<2.5	--	1.5	--	0.02	0.20	0.05
72-0104	10/07/97	13:02	51	77	--	80	**	--	1.3	--	0.05	0.24	0.04
72-0119	11/04/97	14:14	38	57	--	55	4.6	--	2.4	--	0.04	0.31	0.08
CHARLES RIVER													
Station: CR00, Mile Point: 8.9													
Description: approximately 100 feet downstream/east of Watertown Dam, Watertown.													
72-0123	12/09/97	9:00	27	61	--	**	**	--	**	--	0.09	0.67	0.04
72-0159	03/17/98	8:29	21	35	--	70	1.6	--	2.6	--	0.04	0.48	0.03
72-0180	04/22/98	8:20	25	47	--	65	8.4	--	2.2	--	0.07	0.62	0.09
CHEESE CAKE BROOK													
Station: CB01, Mile Point: 0.01													
Description: at mouth appproximately 10 meters upstream of confluence, Newton.													
72-0004	06/17/97	9:02	40	106	--	145	<2.5	--	--	--	<0.02	2.2	0.03
72-0049	07/14/97	9:27	39	91	--	155	<2.5	--	0.35	--	<0.02	1.5	0.03
72-0068	08/20/97	9:26	39	107	--	150	<2.5	--	0.35	--	0.06	2.0	0.04
72-0103	10/07/97	12:30	38	119	--	167	**	--	0.30	--	<0.02	2.2	0.03
72-0118	11/04/97	13:54	33	81	--	110	<2.5	--	0.98	--	0.23	1.5	0.11
72-0127	12/09/97	9:40	31	36	--	**	**	--	**	--	<0.02	0.51	0.03
72-0163	03/17/98	9:14	40	85	--	150	<1.0	--	0.91	--	0.02	2.0	0.10
72-0183	04/22/98	8:51	35	91	--	160	<1.0	--	0.50	--	<0.02	2.0	0.02

** = missing/censored data -- = no data

Table B4. 1997 DEP DWM Charles River Watershed, instream physico/chemical data. All units in mg/L unless otherwise noted. (Continued)

		Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
BEAVER BROOK													
Station: BE01, Mile Point: 0.4													
Description: upstream/north side at Route 60 (downstream/south of Lyman Pond), Waltham.													
72-0050	07/14/97	9:44	63	84	--	128	7.2	--	5.8	--	0.67	0.80	0.15
72-0069	08/20/97	9:51	45	68	--	70	6.6	--	3.8	--	0.68	0.58	0.16
BEAVER BROOK													
Station: BE00, Mile Point: 0.01													
Description: approximately 100 feet downstream/south of River Street from culvert in parking lot (convenience/appliance store), Waltham.													
72-0102	10/07/97	12:11	50	56	--	80	**	--	2.3	--	0.56	0.85	0.16
72-0117	11/04/97	13:34	25	67	--	65	5.8	--	2.0	--	0.10	0.33	0.16
72-0128	12/09/97	10:23	39	100	--	**	**	--	**	--	0.12	0.86	0.06
72-0164	03/17/98	10:05	37	81	--	130	1.6	--	2.2	--	0.06	1.1	0.04
72-0185	04/22/98	9:11	37	72	--	110	3.4	--	2.2	--	0.02	0.50	0.06
STONY BROOK													
Station: ST01, Mile Point: 0.1													
Description: upstream/northwest at Church Street, Weston.													
72-0005	06/17/97	9:35	31	43	--	24	2.9	--	--	--	<0.02	0.46	0.08
72-0051	07/14/97	10:06	31	55	--	36	<2.5	--	1.6	--	0.03	1.2	0.02
72-0070	08/20/97	10:20	34	52	--	32	<2.5	--	0.85	--	<0.02	1.0	0.01
72-0101	10/07/97	11:15	33	56	--	33	**	--	1.4	--	<0.02	1.1	0.01
72-0116	11/04/97	12:08	19	61	--	35	<2.5	--	0.99	--	<0.02	0.25	0.02
ROSEMARY BROOK													
Station: RB01, Mile Point: 0.1													
Description: approximately 75 meters downstream/north of Barton Road, Wellesley.													
72-0006	06/17/97	10:08	51	78	--	82	<2.5	--	--	--	0.07	0.47	0.11
72-0052	07/14/97	10:31	53	69	--	108	<2.5	--	2.0	--	0.05	0.38	0.08
72-0071	08/20/97	10:53	46	87	--	110	8.0	--	4.8	--	0.07	0.67	0.12
72-0100	10/07/97	10:48	36	83	--	107	**	--	1.7	--	0.06	0.33	0.06
72-0115	11/04/97	11:41	25	62	--	65	11	--	2.5	--	0.06	0.11	0.11
72-0130	12/09/97	11:23	31	71	--	**	**	--	**	--	0.05	0.58	0.05
72-0166	03/17/98	11:05	29	54	--	90	5.0	--	2.8	--	<0.02	0.62	0.04
72-0187	04/22/98	10:00	33	58	--	75	7.4	--	1.9	--	<0.02	0.25	0.05

** = missing/censored data -- = no data

Table B4. 1997 DEP DWM Charles River Watershed, instream physico/chemical data. All units in mg/L unless otherwise noted. (Continued)

		Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
SOUTH MEADOW BROOK													
Station: SM01, Mile Point: 0.4													
Description: approximately 100 meters downstream/west of Needham Street, Newton.													
72-0007	06/17/97	10:45	80	127	--	150	25	--	--	--	0.06	1.1	0.13
72-0053	07/14/97	10:54	90	122	--	175	6.0	--	1.8	--	0.18	1.1	0.09
72-0072	08/20/97	11:37	86	114	--	150	<2.5	--	1.9	--	0.26	0.83	0.11
72-0099	10/07/97	10:24	87	146	--	180	**	--	2.3	--	0.12	0.62	0.20
72-0114	11/04/97	11:06	63	97	--	100	<2.5	--	1.4	--	0.03	1.1	0.08
72-0131	12/09/97	11:48	84	127	--	**	**	--	**	--	0.02	1.2	0.03
72-0167	03/17/98	11:47	58	100	--	150	2.4	--	5.9	--	0.08	1.3	0.05
72-0188	04/22/98	10:51	62	100	--	140	<1.0	--	0.90	--	0.07	1.3	0.03
SAWMILL BROOK													
Station: SB01, Mile Point: 1.1													
Description: approximately 10 meters upstream/northeast of Baker Street, Boston. (approximately 1 meter upstream of the foot bridge)													
72-0008	06/17/97	11:19	71	119	--	220	<2.5	--	--	--	0.30	2.3	0.15
72-0054	07/14/97	11:19	57	16	--	200	3.0	--	3.2	--	0.76	2.0	0.10
72-0073	08/20/97	12:09	38	59	--	95	3.0	--	6.1	--	0.90	0.80	0.27
72-0132	12/09/97	12:22	55	109	--	**	**	--	**	--	0.40	1.3	0.11
72-0168	03/17/98	12:22	56	94	--	130	1.2	--	2.4	--	0.14	1.5	0.05
72-0189	04/22/98	11:18	52	93	--	150	1.0	--	1.7	--	0.19	1.3	0.07
ALDER BROOK													
Station: AB01, Mile Point: 0.1													
Description: approximately 5 meters downstream/southeast of South Street, Needham.													
72-0009		06/17/97	11:45	25	123	--	98	<2.5	--	--	--	<0.02	1.3	0.09
72-0055		07/14/97	11:39	29	71	--	90	2.6	--	1.3	--	0.14	1.2	0.05
72-0074		08/20/97	12:39	26	59	--	80	5.2	--	2.4	--	0.02	1.1	0.05
72-0098		10/07/97	9:56	26	60	--	78	**	--	0.60	--	0.03	1.1	0.04
72-0113		11/04/97	10:44	24	58	--	75	3.8	--	1.1	--	0.04	0.95	0.06
72-0139	72-0140	12/09/97	10:04	25	64	--	**	**	--	**	--	<0.02	1.5	0.03
72-0140	72-0139	12/09/97	10:04	24	65	--	**	**	--	**	--	<0.02	1.5	0.03
72-0176		03/17/98	11:15	20	53	--	92	3.8	--	2.9	--	<0.02	1.8	0.02
72-0197	72-0198	04/22/98	9:53	24	54	--	85	3.2	--	1.4	--	0.04	1.1	0.02
72-0198	72-0197	04/22/98	9:53	24	54	--	84	2.6	--	1.4	--	0.02	1.1	0.03

** = missing/censored data -- = no data

Table B4. 1997 DEP DWM Charles River Watershed, instream physico/chemical data. All units in mg/L unless otherwise noted. (Continued)

		Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
ROCK MEADOW BROOK													
Station: RM01, Mile Point: 1.1													
Description: upstream/southwest at Summer Street, Westwood.													
72-0013	06/17/97	11:04	23	40	--	96	<2.5	--	--	--	<0.02	0.15	0.05
72-0059	07/14/97	10:15	31	46	--	76	<2.5	--	1.9	--	0.02	0.20	0.04
72-0078	08/20/97	9:38	37	47	--	80	11	--	2.2	--	0.02	0.26	0.03
72-0138	12/09/97	9:43	11	55	--	**	**	--	**	--	<0.02	0.17	0.02
72-0175	03/17/98	10:48	11	30	--	74	<1.0	--	0.78	--	<0.02	0.39	0.03
72-0196	04/22/98	10:16	16	35	--	80	3.0	--	0.90	--	0.02	0.20	0.03
POWISSETT BROOK													
Station: PB01, Mile Point: 0.6													
Description: downstream/north at Wilsondale Street, Dover.													
72-0014	06/17/97	11:41	9.0	12	--	12	16	--	--	--	<0.02	0.03	0.07
72-0030	07/01/97	10:20	--	--	--	--	--	--	--	--	--	--	--
72-0060	07/14/97	10:35	11	16	--	12	3.6	--	2.1	--	0.05	<0.02	0.04
72-0079	08/20/97	**	*Not enough flow to take sample*										
72-0174	03/17/98	10:29	3.0	11	--	12	2.0	--	0.53	--	<0.02	<0.02	0.02
72-0195	04/22/98	10:34	3.0	10	--	10	<1.0	--	0.60	--	<0.02	<0.02	0.02
TROUT BROOK													
Station: TB01, Mile Point: 1													
Description: approximately 5 meters downstream/north of Haven Street, Dover.													
72-0015	06/17/97	12:34	16	41	--	43	<2.5	--	--	--	0.02	1.1	0.02
72-0061	07/14/97	11:05	16	47	--	47	<2.5	--	0.80	--	<0.02	1.4	0.01
72-0080	08/20/97	10:24	17	41	--	43	<2.5	--	0.75	--	0.02	1.2	0.01
72-0097	10/07/97	8:46	18	41	--	40	**	--	0.70	--	<0.02	0.92	0.02
72-0112	11/04/97	8:52	12	64	--	35	<2.5	--	0.80	--	<0.02	0.42	0.03
72-0137	12/09/97	9:20	14	41	--	**	**	--	**	--	<0.02	0.81	0.02
72-0171	03/17/98	9:50	8.0	26	--	30	<1.0	--	0.28	--	<0.02	0.60	0.01
72-0192	04/22/98	9:26	11	28	--	30	<1.0	--	0.40	--	<0.02	0.50	0.01

** = missing/censored data -- = no data

Table B4. 1997 DEP DWM Charles River Watershed, instream physico/chemical data. All units in mg/L unless otherwise noted. (Continued)

			Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
WABAN BROOK														
Station: WB01, Mile Point: 0.5														
Description: downstream/south at dirt road off of Service Drive, Wellesley.														
72-0081		08/20/97	10:56	37	58	--	80	<2.5	--	1.2	--	<0.02	0.10	0.02
72-0095		10/07/97	9:20	37	61	--	77	**	--	1.4	--	<0.02	0.10	0.03
72-0110		11/04/97	10:18	33	59	--	75	3.4	--	0.92	--	<0.02	0.07	0.06
72-0135		12/09/97	11:12	34	57	--	**	**	--	**	--	<0.02	<0.02	0.02
72-0172	72-0177	03/17/98	12:43	23	50	--	96	1.4	--	1.4	--	<0.02	0.45	0.02
72-0177	72-0172	03/17/98	12:43	20	51	--	86	1.2	--	1.3	--	0.02	0.45	0.02
72-0193		04/22/98	11:40	22	49	--	85	1.8	--	1.0	--	<0.02	0.32	0.02
FULLER BROOK														
Station: FB01, Mile Point: 0.3														
Description: approximately 5 meters upstream/north of Dover Street, Wellesley.														
72-0016	72-0017	06/17/97	13:56	58	95	--	78	<2.5	--	--	--	0.06	1.2	0.04
72-0017	72-0016	06/17/97	13:56	58	108	--	78	<2.5	--	--	--	0.04	1.2	0.06
72-0062	72-0063	07/14/97	12:32	54	85	--	92	<2.5	--	1.2	--	0.04	1.3	0.06
72-0063	72-0062	07/14/97	12:32	55	84	--	95	<2.5	--	1.5	--	0.05	1.2	0.05
72-0082	72-0083	08/20/97	11:15	44	78	--	68	<2.5	--	1.0	--	0.03	0.93	0.06
72-0083	72-0082	08/20/97	11:15	44	78	--	70	<2.5	--	1.0	--	0.02	1.2	0.06
72-0096		10/07/97	9:34	46	87	--	63	**	--	0.80	--	<0.02	1.1	0.04
72-0111		11/04/97	10:07	35	89	--	58	<2.5	--	1.3	--	<0.02	0.44	0.06
72-0136		12/09/97	10:50	37	103	--	**	**	--	**	--	0.04	1.1	0.02
72-0173		03/17/98	12:19	39	69	--	72	<1.0	--	1.2	--	0.04	1.1	0.02
72-0194		04/22/98	11:15	40	67	--	52	2.2	--	1.3	--	0.03	0.66	0.03

** = missing/censored data -- = no data

Table B5. 1997/1998 DEP DWM Charles River Watershed, bacteria data. Units in colonies/100 mls.

			Time (24hr)	FECAL	E-COLI	ENTEROCOCCUS	AEROMONAS
Unnamed and/or Undefined SARIS							
Station: ST00, Mile Point: 0.1							
Description: 30 feet downstream/east of South Street/River Street below outlet Stony Brook Reservoir, Waltham/Weston.							
72-0129		12/09/97	10:58	<20	<20	<100	10,000
72-0165		03/17/98	10:35	<20	<20	20	--
72-0186		04/22/98	9:35	<20	<20	<20	--
Unnamed and/or Undefined SARIS							
Station: BB01, Mile Point: 0.1							
Description: unnamed tributary (outlet Houghton Pond, inlet Factory Pond) to Bogastow Brook, downstream/southeast at Route 16, Holliston.							
72-0036		07/01/97	9:15	100	--	4,000	--
72-0086	72-0087	08/19/97	11:50	280	40	**	29,000
72-0087	72-0086	08/19/97	11:50	280	<20	**	55,000
Unnamed and/or Undefined SARIS							
Station: BB07, Mile Point: 0.1							
Description: downstream/east side at Exchange Street, Millis. (unnamed tributary to Bogastow Brook)							
72-0042		07/01/97		---------- *Not enough flow to take sample*----------			
Unnamed and/or Undefined SARIS							
Station: LB01, Mile Point: 0.01							
Description: 10 feet downstream/north of California Street, Watertown. Unnamed tributary locally known as Laundry Brook.							
72-0020	07/01/97		8:15	2,440	1,200	2,000	800,000
72-0047	72-0048	07/14/97	9:07	260	60	--	--
72-0048	72-0047	07/14/97	9:07	240	160	--	--
72-0066	72-0067	08/20/97	9:02	240	100	**	37,000
72-0067	72-0066	08/20/97	9:02	300	240	**	45,000
72-0105	72-0106	10/07/97	13:21	760	320	--	14,000
72-0106	72-0105	10/07/97	13:21	600	400	--	16,000
72-0120	72-0121	11/04/97	14:24	20	<20	--	--
72-0121	72-0120	11/04/97	14:24	**	**	--	--
72-0124	72-0125	12/09/97	9:19	4,000	1,000	1,000	100,000
72-0125	72-0124	12/09/97	9:19	1,200	700	1,200	100,000
72-0160	72-0161	03/17/98	8:41	2,200	540	1,040	--
72-0161	72-0160	03/17/98	8:41	2,100	660	1,000	--
72-0181	72-0182	04/22/98	8:30	5,000	960	600	--
72-0182	72-0181	04/22/98	8:30	6,000	3,000	860	--
CHARLES RIVER							
Station: CR03, Mile Point: 41							
Description: upstream/west at Walker Street, Medway.							
72-0034	72-0035	07/01/97	8:40	220	--	**	--
72-0035	72-0034	07/01/97	8:40	*	--	**	--
72-0058		07/14/97	9:32	500	100	--	--
72-0077		08/20/97	8:49	120	100	1,900	48,000
72-0093		10/07/97	8:03	460	120	--	6,000
72-0108		11/04/97	8:01	240	60	--	--
72-0133		12/09/97	8:35	<20	<20	<100	**
72-0169		03/17/98	9:10	<20	<20	40	--
72-0190		04/22/98	8:42	80	<20	<20	--

* = interference ** = missing/censored data -- = no data

Table B5. 1997/1998 DEP DWM Charles River Watershed, bacteria data. Units = colonies/100 ml. (Continued)

		Time (24hr)	FECAL	E-COLI	ENTEROCOCCUS	AEROMONAS
CHARLES RIVER						
Station: CR02, Mile Point: 19.9						
Description: upstream/south at unnamed street which is due northeast of Schaller Street, Wellesley/Dover.						
72-0044	07/01/97	11:30	200	--	60	--
72-0057	07/14/97	11:30	200	20	--	--
72-0076	08/20/97	11:48	160	20	300	39,000
72-0094	10/07/97	9:01	100	40	--	13,000
72-0109	11/04/97	9:14	**	**	--	--
72-0134	12/09/97	12:25	60	40	<100	**
72-0170	03/17/98	13:04	20	<20	<20	--
72-0191	04/22/98	12:04	60	<20	<20	--
CHARLES RIVER						
Station: CR01, Mile Point: 9						
Description: sampled from the upstream/west side of footbridge above Watértown Dam, Watertown.						
72-0019	07/01/97	8:00	280	120	240	1,000,000
72-0046	07/14/97	9:00	100	40	--	--
72-0065	08/20/97	8:40	*	20	**	25,000
72-0104	10/07/97	13:02	360	40	--	9,200
72-0119	11/04/97	14:14	140	40	--	--
CHARLES RIVER						
Station: CR00, Mile Point: 8.9						
Description: approximately 100 feet downstream/east of Watertown Dam, Watertown.						
72-0123	12/09/97	9:00	500	80	200	100,000
72-0153 72-0154	01/28/98	11:27	2,400	1,400	1,200	500
72-0154 72-0153	01/28/98	11:27	1,200	1,000	1,000	800
72-0159	03/17/98	8:29	200	60	180	--
72-0180	04/22/98	8:20	920	20	340	--
CHEESE CAKE BROOK						
Station: CB05, Mile Point: 1.11						
Description: upstream/west side at Eddy Street, Newton.						
72-0152	01/28/98	11:10	1,200	320	60	700
Pipe/Discharge to CHEESE CAKE BROOK						
Station: CBE2, Mile Point: 1.1						
Description: stormdrain pipe comes in a couple feet downstream/northeast of Eddy Street, Newton.						
72-0150	01/28/98	11:02	260	20	<20	100
Pipe/Discharge to CHEESE CAKE BROOK						
Station: CBE1, Mile Point: 0.8						
Description: stormdrain pipe comes in east side of Cheese Cake Brook approximately 10 feet upstream/south of Watertown Street, Newton.						
72-0142	12/09/97	10:02	50,000	10,000	16,000	3,700,000
Pipe/Discharge to CHEESE CAKE BROOK						
Station: CBE0, Mile Point: 0.6						
Description: pipe adjacent to Albemarle Park swimming pool approximately 100 meters upstream/south of Crafts Street, Newton.						
72-0149	01/28/98	10:41	<20	<20	<20	500
CHEESE CAKE BROOK						
Station: CB02, Mile Point: 0.4						
Description: upstream/south side at Crafts Street, Newton.						
72-0151	01/28/98	10:47	1,200	200	60	700

* = interference ** = missing/censored data -- = no data

Table B5. 1997/1998 DEP DWM Charles River Watershed, bacteria data. Units = colonies/100 ml. (Continued)

		Time (24hr)	FECAL	E-COLI	ENTEROCOCCUS	AEROMONAS
CHEESE CAKE BROOK						
Station: CB01, Mile Point: 0.01						
Description: at mouth appproximately 10 meters upstream of confluence, Newton.						
72-0021	07/01/97	8:21	800	240	540	1,300,000
72-0049	07/14/97	9:27	840	40	--	--
72-0068	08/20/97	9:26	1,800	700	**	48,000
72-0103	10/07/97	12:30	360	80	--	18,000
72-0118	11/04/97	13:54	4,000	1,760	--	--
72-0127	12/09/97	9:40	800	800	700	8,200
72-0163	03/17/98	9:14	600	<20	460	--
72-0183	04/22/98	8:51	340	<20	40	--
Pipe/Discharge to BEAVER BROOK						
Station: BEE2, Mile Point: 0.61						
Description: from stormdrain pipe upstream/east at Route 60, Waltham. (upstream/east of Lyman Pond)						
72-0156	01/28/98	7:52	240	200	80	1,000
Pipe/Discharge to BEAVER BROOK						
Station: BEE1, Mile Point: 0.6						
Description: from stormdrain pipe downstream/west at Route 60 (upstream/east of Lyman Pond), Waltham.						
72-0155	01/28/98	7:44	480	240	280	3,000
BEAVER BROOK						
Station: BE01, Mile Point: 0.4						
Description: upstream/north side at Route 60 (downstream/south of Lyman Pond), Waltham.						
72-0022	07/01/97	8:35	2,000	900	600	1,500,000
72-0050	07/14/97	9:44	2,000	1,600	--	--
72-0069	08/20/97	9:51	1,400	800	4,000	31,000
BEAVER BROOK						
Station: BE00, Mile Point: 0.01						
Description: approximately 100 feet downstream/south of River Street from culvert in parking lot (convenience/appliance store), Waltham.						
72-0102	10/07/97	12:11	4,400	900	--	31,000
72-0117	11/04/97	13:34	800	500	--	--
72-0128	12/09/97	10:23	1,400	200	1,500	80,000
72-0164	03/17/98	10:05	480	20	180	--
72-0185	04/22/98	9:11	2,000	100	100	--
STONY BROOK						
Station: ST01, Mile Point: 0.1						
Description: upstream/northwest at Church Street, Weston.						
72-0023	72-0024	07/01/97	8:56	120	20	140	400,000
72-0024	72-0023	07/01/97	8:56	60	40	200	6,000,000
72-0051		07/14/97	10:06	80	<20	--	--
72-0070		08/20/97	10:20	80	100	**	12,000
72-0101		10/07/97	11:15	40	60	--	3,300
72-0116		11/04/97	12:08	480	160	--	--
ROSEMARY BROOK						
Station: RB01, Mile Point: 0.1						
Description: approximately 75 meters downstream/north of Barton Road, Wellesley.						
72-0025		07/01/97	9:13	80	100	60	1,200,000
72-0052		07/14/97	10:31	80	200	--	--
72-0071		08/20/97	10:53	180	80	**	28,000
72-0100		10/07/97	10:48	60	60	--	3,500
72-0115		11/04/97	11:41	200	100	--	--
72-0130		12/09/97	11:23	200	60	40	200,000
72-0166		03/17/98	11:05	<20	<20	40	--
72-0187		04/22/98	10:00	40	<20	<20	--

* = interference ** = missing/censored data -- = no data

Table B5. 1997/1998 DEP DWM Charles River Watershed, bacteria data. Units = colonies/100 ml. (Continued)

		Time (24hr)	FECAL	E-COLI	ENTEROCOCCUS	AEROMONAS
SOUTH MEADOW BROOK						
Station: SM02, Mile Point: 0.7						
Description: downstream/southwest at Winchester Street, Newton.						
72-0148	01/28/98	10:15	320	220	200	1,200
Pipe/Discharge to SOUTH MEADOW BROOK						
Station: SME1, Mile Point: 0.41						
Description: stormdrain pipe approximately 3 meters upstream/east of SM01, Newton.						
72-0143	12/09/97	11:56	200	120	<100	100,000
SOUTH MEADOW BROOK						
Station: SM01, Mile Point: 0.4						
Description: approximately 100 meters downstream/west of Needham Street, Newton.						
72-0026	07/01/97	9:27	1,600	600	80	1,100,000
72-0053	07/14/97	10:54	1,300	440	--	--
72-0072	08/20/97	11:37	1,800	780	2,000	38,000
72-0099	10/07/97	10:24	700	500	--	25,000
72-0114	11/04/97	11:06	1,000	500	--	--
72-0131	12/09/97	11:48	3,600	400	1,200	100,000
72-0167	03/17/98	11:47	200	<20	260	--
72-0188	04/22/98	10:51	2,000	<20	340	--
SAWMILL BROOK						
Station: SB02, Mile Point: 1.3						
Description: approximately 100 to 200 meters upstream/northeast of Baker Street, Boston. (directly upstream of SBE1)						
72-0146	01/28/98	9:55	200	120	100	1,000
Pipe/Discharge to SAWMILL BROOK						
Station: SBE1, Mile Point: 1.29						
Description: stormdrain pipe approximately 100 to 200 meters upstream/northeast of Baker Street, Boston						
72-0147	01/28/98	9:49	4,000	2,400	960	10,000
SAWMILL BROOK						
Station: SB01, Mile Point: 1.1						
Description: approximately 10 meters upstream/northeast of Baker Street, Boston. (approximately 1 meter upstream of the foot bridge)						
72-0027	07/01/97	9:43	1,720	--	2,100	1,300,000
72-0054	07/14/97	11:19	1,600	900	--	--
72-0073	08/20/97	12:09	780	360	1,000	13,000
72-0132	12/09/97	12:22	7,000	3,000	2,100	1,300,000
72-0168	03/17/98	12:22	520	60	660	--
72-0189	04/22/98	11:18	3,000	800	100	--
ALDER BROOK						
Station: AB01, Mile Point: 0.1						
Description: approximately 5 meters downstream/southeast of South Street, Needham.						
72-0028	07/01/97	10:05	1,280	--	500	200,000
72-0055	07/14/97	11:39	100	20	--	--
72-0074	08/20/97	12:39	320	140	1,000	30,000
72-0098	10/07/97	9:56	240	140	--	9,800
72-0113	11/04/97	10:44	260	80	--	--
72-0139 72-0140	12/09/97	10:04	400	300	300	**
72-0140 72-0139	12/09/97	10:04	900	200	100	8,000
72-0176	03/17/98	11:15	100	<20	160	--
72-0197 72-0198	04/22/98	9:53	60	<20	140	--
72-0198 72-0197	04/22/98	9:53	60	40	--	--

* = interference ** = missing/censored data -- = no data

Table B5. 1997/1998 DEP DWM Charles River Watershed, bacteria data. Units = colonies/100 ml. (Continued)

		Time (24hr)	FECAL	E-COLI	ENTEROCOCCUS	AEROMONAS
ROCK MEADOW BROOK						
Station: RM01, Mile Point: 1.1						
Description: upstream/southwest at Summer Street, Westwood.						
72-0029	07/01/97	10:11	600	--	900	400,000
72-0059	07/14/97	10:15	400	100	--	--
72-0078	08/20/97	9:38	60	<20	600	7,000
72-0138	12/09/97	9:43	500	<100	<100	**
72-0175	03/17/98	10:48	<20	<20	60	--
72-0196	04/22/98	10:16	<20	<20	<20	--
POWISSETT BROOK						
Station: PB01, Mile Point: 0.6						
Description: downstream/north at Wilsondale Street, Dover.						
72-0030	07/01/97	10:20	40	--	<20	1,500,000
72-0060	07/14/97	10:35	20	<20	--	--
72-0079	08/20/97		---------- *Not enough flow to take sample*----------			
72-0174	03/17/98	10:29	<20	<20	20	--
72-0195	04/22/98	10:34	<20	<20	<20	--
TROUT BROOK						
Station: TB01, Mile Point: 1						
Description: approximately 5 meters downstream/north of Haven Street, Dover.						
72-0031	07/01/97	10:33	80	--	<20	300,000
72-0061	07/14/97	11:05	200	<20	--	--
72-0080	08/20/97	10:24	260	100	100	1,000
72-0097	10/07/97	8:46	140	60	--	2,700
72-0112	11/04/97	8:52	**	**	--	--
72-0137	12/09/97	9:20	360	40	100	100,000
72-0171	03/17/98	9:50	<20	<20	<20	--
72-0192	04/22/98	9:26	<20	<20	40	--
WABAN BROOK						
Station: WB01, Mile Point: 0.5						
Description: downstream/south at dirt road off of Service Drive, Wellesley.						
72-0081	08/20/97	10:56	140	160	300	22,000
72-0095	10/07/97	9:20	<20	<20	--	12,000
72-0110	11/04/97	10:18	40	<20	--	--
72-0135	12/09/97	11:12	20	<20	300	**
72-0172 72-0177	03/17/98	12:43	<20	<20	<20	--
72-0177 72-0172	03/17/98	12:43	<20	<20	<20	--
72-0193	04/22/98	11:40	<20	<20	20	--
FULLER BROOK						
Station: FB03, Mile Point: 1.01						
Description: approximately 102 meters upstream/north of Cameron Street (above duckpond tributary), Wellesley.						
72-0145	01/28/98	8:35	200	120	100	1,600
FULLER BROOK						
Station: FB02, Mile Point: 1						
Description: approximately 100 meters upstream/north of Cameron Street (below duckpond tributary), Wellesley.						
72-0144	01/28/98	8:30	1,600	800	<20	1,400

* = interference ** = missing/censored data -- = no data

Table B5. 1997/1998 DEP DWM Charles River Watershed, bacteria data. Units = colonies/100 ml. (Continued)

			Time (24hr)	FECAL	E-COLI	ENTEROCOCCUS	AEROMONAS
FULLER BROOK							
Station: FB01, Mile Point: 0.3							
Description: approximately 5 meters upstream/north of Dover Street, Wellesley.							
72-0032		07/01/97	10:44	1,600	--	600	--
72-0062	72-0063	07/14/97	12:32	3,600	920	--	--
72-0063	72-0062	07/14/97	12:32	4,000	800	--	--
72-0082	72-0083	08/20/97	11:15	1,400	680	400	25,000
72-0083	72-0082	08/20/97	11:15	1,500	520	**	23,000
72-0096		10/07/97	9:34	1,000	360	--	8,800
72-0111		11/04/97	10:07	**	**	--	--
72-0136		12/09/97	10:50	600	100	600	**
72-0173		03/17/98	12:19	40	<20	40	--
72-0194		04/22/98	11:15	300	40	20	--
BOGASTOW BROOK							
Station: BB03, Mile Point: 8.3							
Description: upstream/south side at Lowland Street, Holliston.							
72-0038		07/01/97	9:40	140	--	400	--
72-0088		08/19/97	12:00	160	20	1,000	24,000
BOGASTOW BROOK							
Station: BB04, Mile Point: 7							
Description: upstream/north at Fiske Street, Holliston.							
72-0089		08/19/97	12:30	600	60	**	37,000
BOGASTOW BROOK							
Station: BB04A, Mile Point:6.1							
Description: upstream/north at Central Street, Holliston.							
72-0039		07/01/97	9:55	180	--	200	--
72-0090		08/19/97	12:35	300	40	**	41,000
BOGASTOW BROOK							
Station: BB05, Mile Point: 5.2							
Description: upstream/north at Orchard Street, Millis.							
72-0040		07/01/97	10:04	160	--	<20	--
72-0091		08/19/97	12:45	460	120	**	39,000
BOGASTOW BROOK							
Station: BB06, Mile Point: 3							
Description: upstream/south at Middlesex Street, Millis.							
72-0041		07/01/97	10:20	120	--	160	--
72-0092		08/19/97	1:00	220	60	**	34,000
BOGASTOW BROOK							
Station: BB08, Mile Point: 2							
Description: upstream/west side at Orchard Street below Bogastow Pond outlet (in stream not in impoundment), Millis.							
72-0043		07/01/97	10:50	100	--	60	--
72-0200		08/19/97	1:15	80	<20	**	27,000
DOPPING BROOK							
Station: BB02, Mile Point: 0.7							
Description: upstream/north side at Whitney Street bridge, Holliston.							
72-0037		07/01/97	9:30	800	--	1,000	--

* = interference ** = missing/censored data -- = no data

Table B6. Results of optical brightener screening in the Charles River Watershed conducted 19 August 1997 to 20 May 1998.

Station/ Location	Date Deployed	Date Retrieved	Results
BB03 Bogastow Brook @Lowland St., Holliston	19 Aug 1997	26 Aug 1997	Inconclusive
BB04 Bogastow Brook @Fiske St., Holliston	19 Aug 1997	26 Aug 1997	Inconclusive
BB04A Bogastow Brook @Central St., Holliston	19 Aug 1997	26 Aug 1997	Inconclusive
BB06 Bogastow Brook @Middlesex St., Holliston	19 Aug 1997	26 Aug 1997	Inconclusive
BB04 Bogastow Brook @Fiske St., Holliston	16 Sept 1997	18 Sept 1997	Inconclusive
BB06 Bogastow Brook @Middlesex St., Holliston	16 Sept 1997	18 Sept 1997	Inconclusive
LB01 Laundry Brook @Watertown Dam, Watertown	16 Sept 1997	18 Sept 1997	Positive
CB01 Cheese Cake Brook @Nevada St., Newton	16 Sept 1997	18 Sept 1997	Positive
BE01 Beaver Brook @Rte 60, Waltham	16 Sept 1997	18 Sept 1997	Inconclusive
BB04 Bogastow Brook @Fiske St., Holliston	18 Sept 1997	19 Sept 1997	Negative
BB06 Bogastow Brook @Middlesex St., Holliston	18 Sept 1997	19 Sept 1997	Negative
LB01 Laundry Brook @Watertown Dam, Watertown	18 Sept 1997	19 Sept 1997	Positive
CB01 Cheese Cake Brook @Nevada St., Newton	18 Sept 1997	19 Sept 1997	Positive
BE00 Beaver Brook @confluence with Charles River, Waltham	18 Sept 1997	19 Sept 1997	Positive
CB02 Cheese Cake Brook @Crafts St., Newton	2 Oct 1997	3 Oct 1997	Positive
CB02 Cheese Cake Brook @Crafts St., Newton	3 Oct 1997	5 Oct 1997	Positive
CB03 Cheese Cake Brook adjacent to 353 Albermarle St.(downstream Watertown St.) (downstream from storm drain), Newton	2 Oct 1997	3 Oct 1997	Positive
CB03 Cheese Cake Brook adjacent to 353 Albermarle St.(downstream Watertown St.) (downstream from storm drain), Newton	3 Oct 1997	5 Oct 1997	Positive
BE01A Beaver Brook Upstream from Rte 60 (upstream from Lyman Pond) (downstream from stormdrain), Waltham	2 Oct 1997	5 Oct 1997	Positive (strong)
BE01A Beaver Brook upstream from Rte 60 (upstream from Lyman Pond) (downstream from stormdrain), Waltham	5 Oct 1997	7 Oct 1997	Positive (strong)
BE01B Beaver Brook @ Beaver St. (downstream from Clematis Brook), Waltham	7 Oct 1997	10 Oct 1997	Positive (weak)
BE01C Beaver Brook upstream from Clematis Brook, Waltham	7 Oct 1997	10 Oct 1997	Positive (weak)
RM01 Rosemary Brook downstream from Barton Rd, Wellesley	7 Oct 1997	10 Oct 1997	Negative

Table B6. Results of optical brightener screening in the Charles River Watershed conducted 19 August 1997 to 20 May 1998. (Continued.)

Station/ Location	Date Deployed	Date Retrieved	Results
FB01 Fuller Brook upstream from Dover St.., Wellesley	7 Oct 1997	10 Oct 1997	Negative
TB01 Trout Brook @Haven St.., Dover	4 Nov 1997	7 Nov 1997	Negative
ST01 Stony Brook @Church St., Weston	4 Nov 1997	7 Nov 1997	Negative
CB03 Cheese Cake Brook adjacent to 353 Albermarle St.(downstream Watertown St.) (downstream from storm drain), Newton	18 Nov 1997	21 Nov 1997	Positive (strong)
CB04 Cheese Cake Brook upstream from Watertown St. (upstream from stormdrain), Newton	18 Nov 1997	21 Nov 1997	Positive (weak)
CB04 Cheese Cake Brook upstream from Watertown St. (upstream from stormdrain), Newton	2 Dec 1997	5 Dec 1997	Positive (weak)
CB05 Cheese Cake Brook upstream from Eddy St. (upstream from stormdrain), Newton	2 Dec 1997	5 Dec 1997	Positive (weak)
CB04A Cheese Cake Brook stormdrain @ Eddy St., Newton	15 Dec 1997	18 Dec 1997	Positive (weak)
CB05 Cheese Cake Brook upstream from Eddy St. (upstream from stormdrain), Newton	15 Dec 1997	18 Dec 1997	Positive (weak)
SB01 Sawmill Brook upstream from. Baker St. (downstream from. stormdrain), Boston	17 Dec 1997	19 Dec 1997	Positive
SM01 South Meadow Brook downstream from. Needham St. (downstream from stormdrain), Newton	17 Dec 1997	22 Dec 1997	Positive
CB06 Cheese Cake Brook @Watertown St. near West Newton Center, Newton	4 Mar 1998 6 Mar 1998	6 Mar 1998 9 Mar 1998	Positive Positive
CR08 Charles River downstream from Rte 16, Wellesley	4 Mar 1998 6 Mar 1998	6 Mar 1998 9 Mar 1998	Positive Positive
SM01A South Meadow Brook upstream from stormdrain (SME1), Newton	15 May 1998 18 May 1998	18 May 1998 20 May 1998	Positive Positive
SM01 South Meadow Brook downstream from Needham St. (downstream from stormdrain), Newton	15 May 1998 18 May 1998	18 May 1998 20 May 1998	Positive Positive

Macroinvertebrates

Results from DEP's 1997 benthic macroinvertebrate study are presented in Appendix C of this report (*Charles River Watershed 1997/1998 Assessment Report*).

Fish Population

Results from DEP's 1997 fish population study (MA DEP 1997b) are presented in Appendix C of this report (*Charles River Watershed 1997/1998 Assessment Report*).

Fish Toxics

Sampling of the Charles River in October 1997 was conducted upstream from the South Natick dam. This sampling resulted in the collection of largemouth bass (*Micropterus salmoides*), yellow perch (*Perca flavescens*), white perch (*Morone americana*), bluegill (*Lepomis macrochirus*), common carp (*Cyprinus carpio*), yellow bullhead (*Ameiurus natalis*) and brown bullhead (*Ameiurus nebulosis*) (Table B7) (MA DEP

1997c). In most cases fish selected for analysis represented species and sizes desirable by the angling public for consumption, as well as fish from different feeding guilds (i.e., predator, invertivore, and omnivore).

Lead, arsenic and cadmium levels were below minimum detection limits (Table B7) defined by EPA analytical methods (Pb=<0.140 mg/kg, As=<0.040 mg/kg, and Cd=<0.020 mg/kg) in all composite samples (skin-off fillets) analyzed. Selenium and mercury were detected in all of the samples analyzed. Mercury ranged from 0.090 mg/kg (yellow perch) to 0.570 mg/kg (largemouth bass) in the fish collected. PCB (Arochlor 1254) was only detected in the composite sample of carp. WES reported a value of 0.52 mg/kg. Organochlorine pesticides were detected in none of the samples analyzed. Note: Sample CRF97-15-17 (bullheads) was not analyzed for % lipids, PCB's or pesticides due to complications at WES.

As part of the cooperative Fish Toxics Monitoring Program results from the DWM fish toxics monitoring are sent to MDPH for interpretation. A discussion of the conclusions drawn by that agency are presented below.

DEPARTMENT OF PUBLIC HEALTH –
FISH CONSUMPTION ADVISORIES CHARLES RIVER (DPH 1998)

Based on the concentration of PCB's found in common carp from the Charles River from the Museum of Science Dam in Boston upstream to the South Natick Dam, and the potential health threat from eating these fish, the DPH has issued the following advisories:

1. "Children under 12, pregnant women and nursing mothers should refrain from consuming carp in order to prevent exposure of developing fetuses and young children to PCBs".

2. "The general public should limit consumption of carp to two meals per month".

Based upon the concentration of mercury found in largemouth bass from the Charles River from the South Natick Dam upstream to the Medway Dam, and the potential health threat from consuming these fish, the MDPH has issued the following advisories:

1. "Children under 12, pregnant women and nursing mothers should refrain from consuming largemouth bass in order to prevent exposure of developing fetuses and young children to mercury".

2. "The general public should limit consumption of largemouth bass to two meals per month".

It should be noted that because of risks associated with elevated levels of mercury in certain species of freshwater fish, the DPH has issued a statewide Interim Freshwater Fish Advisory as of September 1994 (DPH 1994). The interim advisory, issued by MDPH, recommends that "Pregnant women should be advised of the possible health risk from eating fish taken from Massachusetts freshwater bodies in order to prevent exposure of developing fetuses to mercury." The advisory does not include stocked trout or farm-raised fish sold commercially. Within the last ten years, the United States Food and Drug Administration's (USFDA's) Action Level for mercury of 1.0 ppm has been reassessed by many state public health agencies and the EPA. As a result of this reassessment, the DPH has set a total mercury "trigger level" of 0.5 mg/kg for any given species. When the average level of mercury in a particular species exceeds 0.5 mg/kg the DPH issues an advisory to sensitive groups to eat none (of that species). Average concentrations in exceedance of 1.0 mg/kg would result in an advisory by the DPH against consumption of said species by all groups.

Lakes

Lake synoptic survey results (MA DEP 1997d) are presented in Table B8.

Table B7. 1997/1998 DEP DWM Charles River Basin Survey. Fish toxics monitoring data for the Charles River, South Natick. Data expressed in mg/kg unless otherwise noted. All concentrations are in wet weight.

Analysis #	Sample ID	Collection Date	Species Code[1]	Sample Type[2]	Length (cm)	Weight (gm)	Cd	Pb	Hg	As	Se	%Lipids	PCB (µg/g)	Pesticides (µg/g)
Charles River														
Station F0053: at South Natick.														
97044	CRF97-1	10/09/97	LMB	C	43.2	1200	<0.020	<0.140	0.570[3]	<0.040	0.074	0.49	ND	ND
	CRF97-2	10/09/97	LMB	C	42.5	1220								
	CRF97-3	10/09/97	LMB	C	38.8	880								
97045	CRF97-4	10/09/97	C	C	83.8	<9000	<0.020	<0.140	0.380[3]	<0.040	0.172	5.8	0.52*	ND
	CRF97-5	10/09/97	C	C	76.2	6340								
97046	CRF97-6	10/09/97	WP	C	29.8	480	<0.020	<0.140	0.270[3]	<0.040	0.738	1.4	ND	ND
	CRF97-7	10/09/97	WP	C	30.5	480								
	CRF97-8	10/09/97	WP	C	27.2	390								
97047	CRF97-9	10/09/97	YP	C	25.1	240	<0.020	<0.140	0.090[3]	<0.040	0.188	0.17	ND	ND
	CRF97-10	10/09/97	YP	C	18.7	100								
	CRF97-11	10/09/97	YP	C	17.1	90								
97048	CRF97-12	10/09/97	B	C	20.9	210	<0.020	<0.140	0.170[3]	<0.040	0.098	0.17	ND	ND
	CRF97-13	10/09/97	B	C	19.8	200								
	CRF97-14	10/09/97	B	C	19.5	170								
97049	CRF97-15	10/09/97	YB	C	26.5	300	<0.020	<0.140	0.160[3]	<0.040	0.078	**	**	**
	CRF97-16	10/09/97	BB	C	27.9	340								
	CRF97-17	10/09/97	BB	C	18.5	320								

[1]Species
bluegill (B) *Lepomis macrochirus*
brown bullhead (BB) *Ameiurus nebulosus*
common carp (C) *Cyprinus carpio*
largemouth bass (LMB) *Micropterus salmoides*
white perch (WP) *Morone americana*
yellow bullhead (YB) *Ameiurus natalis*
yellow perch (YP) *Perca flavescens*

[2]Sample Type (All samples were fillets with skin off.)
Composite (C)
Individual (I)

[3]Analyzed beyond the EPA recommended holding time of 28 days for mercury in fish tissue.

* Arochlor 1245

** not analyzed

ND - not detected

TABLE B8. 1997 DEP DWM Charles River Watershed, synoptic lake survey data summer 1997.

LAKE, LOCATION	SIZE (Acres)	TROPHIC STATE	OBSERVATIONS, Non-Native Aquatic Plants
Lake Archer, Wrentham	79	M	None noted
Beaver Pond, Bellingham/ Milford	114	E	None noted
Box Pond, Bellingham/ Mendon	40	H	None noted
Cambridge Reservoir **, Waltham/ Lincoln/ Lexington	549	U	None noted
Cambridge Reservoir, Upper Basin **, Lincoln/ Lexington	10	U	None noted
Cedar Swamp Pond, Milford	35	H	None noted
Chestnut Hill Reservoir, Boston	101	U	None noted
Crystal Lake, Newton	24	U	None noted
Dug Pond, Natick	40	U	None noted
Echo Lake **, Milford/ Hopkinton	123	M	None noted
Factory Pond, Holliston	10	H	*Myriophyllum heterophyllum*
Farm Pond, Sherborn	124	U	None noted
Franklin Reservoir, Northeast Franklin	21	E	None noted
Franklin Reservoir, Southwest Franklin	13	E	None noted
Hammond Pond, Newton	21	E	None noted
Hardys Pond, Waltham	41	H	*Trapa natans*
Houghton Pond, Holliston	17	H	*Myriophyllum heterophyllum*
Jamaica Pond, Boston	63	U	None noted
Jennings Pond, Natick	9	H	None noted
Kendrick Street Pond, Needham	40	E	None noted
Linden Pond, Holliston	1	H	None noted
Little Farm Pond, Sherborn	22	H	None noted
Lymans Pond, Dover	3	H	None noted
Mine Brook Pond, Franklin	72	H	None noted
Mirror Lake, Wrentham/ Norfolk	55	E	*Potamogeton crispus*
Morses Pond, Wellesley/ Natick	116	E	*Cabomba caroliniana*, *Myriophyllum heterophyllum* and *M. spicatum*
Noannet Pond, Dover/ Westwood	58	U	*Myriophyllum heterophyllum*
Nonesuch Pond, Weston/ Natick	35	U	None noted
Norumbega Reservoir (North Basin), Weston	14	U	None noted
Norumbega Reservoir (South Basin), Weston	35	U	None noted
Lake Pearl, Wrentham	218	M	None noted
Populatic Pond, Norfolk	40	E	None noted
Sandy Pond **, Lincoln	162	M	None noted
Scarboro Golf Course Pond, Boston	7	H	*Nymphoides peltatum*
Stony Brook Reservoir **, Waltham/ Weston	67	U	None noted
Lake Waban, Wellesley	108	U	*Cabomba caroliniana* and *Myriophyllum spicatum*
Waseeka Sanctuary Pond, Holliston	17	H	None noted
Weld Pond, Dedham	27	E	None noted
Weston Reservoir, Weston	60	U	None noted
Weston Station Pond, Weston	63	E	None noted
Lake Winthrop, Holliston	102	E	*Cabomba caroliniana* and *Myriophyllum heterophyllum*

** Indicates Class A (water supply) waterbody; all others are Class B. Trophic State– O= Oligotrophic, M= Mesotrophic, E= Eutrophic, H= Hypereutrophic, U= Undetermined

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APPENDIX C – 1997 CHARLES RIVER WATERSHED BIOLOGICAL MONITORING

Submitted by

John F. Fiorentino, DEP DWM

In partial fulfillment of 104(b)(3) project titled: Charles River: Swimmable in 2005

5 March 1999

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INTRODUCTION

Biological monitoring is a useful means of detecting anthropogenic impacts to the aquatic community. Resident biota (e.g., benthic macroinvertebrates, fish, periphyton) in a water body are natural monitors of environmental quality and can reveal the effects of episodic and cumulative pollution and habitat alteration (Plafkin et al. 1989, Barbour et al. 1995). Biological surveys and assessments are the primary approaches to biomonitoring.

Biomonitoring was conducted in the Charles River watershed during the summer of 1997 as one of three tasks funded by a grant provided by Section 104(b)(3) of the Clean Water Act (CWA). The project, titled "Charles River: Swimmable in 2005," seeks to further the goals of both the Charles River Watershed Association's (CRWA) Integrated Monitoring, Modeling, and Management (IM3) Project and the Massachusetts Department of Environmental Protection (DEP) Charles River Basin Team. A five year effort, the IM3 project involves the monitoring of flow, water and sediment quality, habitat and biota, the modeling of hydrologic, water quality and economic conditions in the watershed, and the development of a watershed management plan with strategies for improving conditions in the river. Concurrently, the Massachusetts DEP has been implementing its Clean Water Act mandates through the Watershed Approach, a five year cycle of water resource management which entails monitoring, assessment, resource analysis, awarding of grants and permitting for both water quality and quantity, and development of an overall basin regulatory and management framework. DEP assessment work for the Charles River watershed was initiated in May 1997 as a comprehensive water quality (water, fish tissue, habitat, and biological studies) monitoring survey designed to complement the sampling efforts of CRWA and the IM3 study. As a component of the 1997 DEP Charles River basin survey, then, all biological information will assist CRWA in its ongoing modeling and monitoring efforts, and will assist DEP in assessing how best to target state resources to augment ongoing federal and private efforts in the Charles River Basin and to address problems in need of remediation within the watershed.

The main objectives of the biomonitoring component of "Charles River: Swimmable in 2005" were: (a) to determine the biological health of streams within the Charles River watershed by conducting assessments based on aquatic macroinvertebrate communities and other supplemental biological data (periphyton, fish); and (b) to identify problem stream segments so that efforts can be focussed on developing NPDES and Water Management Act permits, stormwater management, and control of other nonpoint sources of pollution.

Specific tasks were:

1. Conduct benthic macroinvertebrate sampling at locations throughout the Charles River watershed. When possible, supplement macroinvertebrate data with fish and periphyton data.

2. Based upon the biological data, identify river segments within the watershed with potential point/nonpoint source pollution problems; and

3. Using the benthic macroinvertebrate data and supporting biological (fish and periphyton), water chemistry, and habitat data, assess the types of water quality problems that are present, and if possible, make recommendations for remedial actions.

The Massachusetts Department of Environmental Protection's Division of Watershed Management (MA DEP DWM) conducted biomonitoring at a total of 25 sites from 8 July 1997 to 3 September 1997. In terms of basin-wide biological sampling, this was the largest effort since 1973. Biomonitoring was utilized to investigate some of the more important perceived problems/issues in the watershed, as expressed by various groups —most specifically, CRWA, DEP Charles River Basin Team, DEP Division of Water Supply, and the Department of Environmental Management. These issues are: 1) Low flow effects resulting from water withdrawals, especially from community groundwater supplies in the rapidly growing towns in the upper watershed. 2) Point source discharges in Milford, Medfield, Medway, Norfolk; and 3) Miscellaneous nonpoint source (NPS) pollution, including habitat degradation, road and agricultural runoff, stormdrain discharges (wet and dry weather), and other sources of nutrient loadings and organic enrichment. The following is a brief summary of each issue, including those streams potentially affected and targeted for bioassessment.

Groundwater Withdrawals/Flow Reduction

The Department of Environmental Protection's Division of Water Supply (DEP DWS) conducted the Upper Charles River Study (Bouck 1997) to investigate water use in the towns of Franklin, Norfolk, Medway, and Millis—all of which are located near the head of the Charles River proximal to Interstate 495. Franklin is presently experiencing one of the largest population growth rates in the state. According to Bouck, the primary aquifers supplying Franklin are presently stressed to the point where future resource planning is essential for the town to maintain its present growth rate. Because the aquifers of this area are generally unconfined, the surface water features (streams, rivers, lakes) are in direct hydraulic connection with the permeable material that provides water to the public water supplies. As a result, water withdrawals that significantly lower the water table can potentially lower adjacent surface water features, and thereby adversely impact wildlife, aquatic habitat, and other water supplies (Bouck 1997).

The principle stressed aquifers in this part of the watershed are along Mine Brook in Franklin, Mill River adjacent to the Franklin/Norfolk border, and the Populatic Pond/Charles River area near the juncture of Franklin, Norfolk, Medway, and Millis. In particular, the portion of the mainstem located between the confluence of Mine Brook and the Charles River, and the CRPCD facility downgradient of Populatic Pond, has been hydologically impacted by the combined withdrawals along Mine brook, Mill River, and Populatic Pond. According to the DWS study, these stressed areas may be unable to handle any future withdrawals without adversely impacting resident aquatic communities. Nevertheless, as communities in the upper Charles River watershed continue to grow at a rapid pace, so do their demands for water supply. Many of these communities are in various stages of obtaining new water supplies, ranging from planning to recently receiving permits for the operation of new groundwater wells.

Flow regime and current velocity are important hydrologic determinants of benthic community structure. Flow volume and velocity/depth combinations can have effects on substrate composition and stability, the amount of channel under water, and food availability (Minshall 1984). Current plays a crucial role in the distribution of benthic macroinvertebrates and fish—current velocity affects an organism's ability to gather food, meet respiratory requirements, avoid competition and predation, and colonize or vacate certain habitats (Minshall 1984). Short-term flow fluctuations may modify benthic communities in several ways, most notably by stranding them in pockets of standing water or on exposed substrates. Mayflies are particularly susceptible to stranding and are relatively intolerant of exposure (Ward 1984). While flow reduction downstream of a water withdrawal probably is not abrupt enough to strand resident biota, decreasing discharge and the subsequent elimination of habitat or favorable flow regimes may induce "drift," or the downstream transport by current of benthic animals as a means of escape or dispersal (Wiley and Kohler 1984; Ward 1984). Decreasing stream discharge may also result in an altered riparian zone, potentially reducing habitat or diversity of flora, as well as allochthonous organic inputs. Changes in riparian habitat and resulting instream trophic structure will be reflected by changes in the aquatic community. In addition to altered flow effects to the downstream lotic community and associated habitat, abrupt reduction in discharge may affect downstream temperature regimes. An unfortunate consequence of these altered temperature regimes may be the elimination of certain species of aquatic organisms (Ward 1984). Thus, stream flow alterations may affect downstream aquatic community composition and structure in a variety of ways.

To investigate potential adverse effects of groundwater withdrawal-induced low flows on the aquatic biota and habitat of the upper Charles River basin, macroinvertebrate biomonitoring was conducted concurrent with flow gauging in the following streams (specific station locations and sampling methodologies utilized will be described in the Methods section of this report):

Mine Brook (Franklin)—This aquifer, subjected to several groundwater withdrawals, is considered a high priority by CRWA and DEP DWS. Sampling was conducted at Route 140 in Franklin, downstream from existing community water supplies (GP Well #1, #2, #3, #6, #10) as well as a proposed groundwater well (proposed State Forest Well) near the headwaters in Miscoe Brook. It should be noted that reconnaissance activities conducted in May 1997 found flow in Miscoe Brook to be nothing more than a "trickle" before it joins Mine Brook. The low flows already prevalent here made it virtually impossible to apply valid macroinvertebrate sampling methodologies in Miscoe Brook.

Dopping Brook (Holliston)—This is another high priority stream with an existing groundwater well (#6) and a proposed well (#7) drawing from an already stressed aquifer in the vicinity of Route 16 (Bouck, DWS,

personal communication). Spring reconnaissance found flow in this small first order stream to exhibit virtually no perceptible velocity. Sampling was conducted at Brook Street.

Jar Brook (Holliston)—This stream is considered a high priority by CRWA, as the sewering of this area will result in the loss of septic system contributions to groundwater supply, placing added stress on the aquifer and surface waters already subjected to low flows (much of Jar Brook ran dry during the summer of 1995) (Bouck, DWS, personal communication). Reduced flow effects here may be compounded by the various forms of nonpoint source pollution in this heavily developed residential area. Sampling was conducted at Travis Road, downstream of Well #2.

Mill River (Norfolk)—Several groundwater wells currently exist along this aquifer, and a new well (Mill River Well) is proposed near the Mill River/Miller Brook confluence, an area experiencing much new residential home construction. Biomonitoring was conducted above and below the site of the proposed Mill River well, and will provide baseline date for future upstream-downstream comparisons of flow effects in this area.

Bogastow Brook (Holliston)—A community public water supply currently exists along this stream just downstream of the East Holliston section of town, an area with several new subdivisions developed over the last twenty years. An upstream-downstream macroinvertebrate sampling approach was taken to bracket the effects of reduced flow in this portion of the sub-watershed. Suspected septic system failure and resulting water quality degradation in this area may compound low flow effects.

*Populatic Pond/Charles River (*Medway/Franklin)—Several groundwater withdrawals (Oakland Well #2, Populatic Well #1, GP Well #8) occur near the juncture of Medway, Franklin, Millis, and Norfolk. In addition, Populatic Pond Well #11 has been proposed just upstream of Populatic Pond. Potentially exacerbating the effects of reduced flow on the aquatic communities downstream of Populatic Pond is the presence of the Charles River Pollution Control District (CRPCD) treatment facility in Medway. Biomonitoring was conducted downstream of Populatic Pond and just upstream of the existing and proposed groundwater wells above the pond. These sampling efforts will also investigate the discharge effects of the CRPCD discharge on instream biota, which will be mentioned later in this report.

Water Quality Impacts/Point Source Pollution

There are several NPDES-permitted point source discharges in the Charles River watershed—most are in the upper-middle portion of the basin. Water quality impacts were evaluated for all point source discharges using macroinvertebrate biomonitoring. In all cases, an upstream-downstream sampling approach was employed, comparing biological integrity above and below the treatment facility. At some locations, biomonitoring data may be complemented with water quality data collected by CRWA. The following discharges were investigated (specific station locations and sampling methodologies utilized will be described in the Methods section of this report):

Charles River:
Milford WWTP/Milford Power Limited Partnership-American National Power (MPLP, formerly ENRON)—The MPLP facility began power generation on July 1, 1994 and has continued on a regular basis since that date. During facility operation, the cooling towers are generally supplied with treated wastewater from the Milford Wastewater Treatment Facility. The Charles River Monitoring Project, called for in the MA DEP Sewer Extension Permit (MA DEP Permit #24633) was issued to MPLP on April 1, 1992. Macroinvertebrate biomonitoring, as required in the permit, was conducted upstream and downstream of the Milford WWTP/MPLP facility by ENSR Consulting and Engineering. Procedures followed in obtaining bioassessment data are defined in the Quality Assurance Project Plan (QAPP) (ENSR 1992) for the Charles River Monitoring Project. DEP will rely on ENSR's biomonitoring efforts and data to investigate the combined effects of effluent and potentially reduced flows on this portion of the river, making the appropriate assessment and management decisions based on the review and analyses of these data.

Charles River Pollution Control District (CRPCD) —Increased sewer pressure in response to Title 5 in the area has led to CRPCD expansion. Monitoring information based on the CRPCD's whole effluent toxicity (WET) data suggests that their effluent is not meeting Chronic No Observed Effect Concentration (CNOEC) limits. Also, the plant's addition of sodium bisulfite for dechlorination is done slightly in "excess," and the

effects of this practice are a potential problem. Macroinvertebrate sampling was conducted at Walker Street, Medway and at Dean Street, Millis to assess discharge effects on the benthic community.

Medfield POTW—This facility's WET data indicated acute toxicity to *C. Dubia* in 4 of 9 test events from 1994-1997. Macroinvertebrate sampling was conducted above and below the treatment plant's discharge in the vacinity of West Street. Suspended artificial substrate samplers were deployed by canoe. While DWM biologists canoed the segment of the river downgradient of West Street prior to sampler deployment, visual observations of the river substrates in the inlet that receives the plant's effluent discharge indicated that solids may be entering the river.

Stop River:
There are three NPDES discharges to this tributary—the Norfolk MCI wastewater treatment facility, Wrentham State School's WWTP, and Southwood Community Hospital's treatment facility. Compounding the effects of these point source inputs may be a reduction in stream flow resulting from several water withdrawals (Norfolk MCI Well #1, #2, #3, #4; Southwood Hospital Well #1, #2) throughout the Stop River watershed. The stream segment from the headwaters to the MCI facility is currently not assessed by DEP DWM, while a 1986 305(b) assessment of the segment from Norfolk MCI to the confluence with the Charles River resulted in non-attainment status for aquatic life due to low dissolved oxygen and organic enrichment. Three macroinvertebrate biomonitoring stations were established to bracket the MCI facility, and the combined effects of the state school and hospital discharges.

Water Quality and Habitat Impacts/Nonpoint Source Pollution

Macroinvertebrate biomonitoring was conducted in ten major tributaries to the lower Charles River (i.e., downstream from the South Natick Dam) and at one mainstem location (Watertown Dam) in an attempt to investigate impacts from both suspected and unknown sources of nonpoint pollution. Pollution impacts from urban and agricultural runoff, habitat degradation, and stormwater are especially prevalent in this heavily developed portion of the watershed. These sampling activities represent the first ever biomonitoring efforts conducted in these streams by DEP, and will thus provide bioassessment data for a number of previously unassessed water bodies and provide baseline biological information for future watershed studies. Biological data at all eleven stations was supplemented with physico-chemical data, as water quality sampling and flow gauging were conducted monthly from May 1997 through May 1998 by DWM. In addition, fish population assessments were conducted at five of the ten tributary stations, representing the first fish population work conducted by DEP in the Charles River watershed.

Macroinvertebrate assessments were conducted in the following streams (specific station locations and sampling methodologies utilized will be described in the Methods section of this report): Fuller Brook, Wellesley; Waban Brook, Wellesley; Trout Brook, Dover; Powissett Brook, Dover; Rock Meadow Brook, Westwood; Alder Brook, Needham; Rosemary Brook, Wellesley; Beaver Brook, Belmont; Stony Brook, Weston; Cheese Cake Brook, Newton; Charles River, Watertown.

METHODS

Macroinvertebrate Sampling and Habitat Assessments

Macroinvertebrate biomonitoring was conducted by DEP DWM biologists at a total of 25 stations, as described in Table 1 and noted in Figure 1. The collection procedure was based on modifications to EPA Rapid Bioassessment Protocols (RBPs) (Plafkin et al. 1989). Bioassessments were conducted at 20 stations (Table 1) based on the RBP III protocol, rather than the RBP II, the latter of which provides a wide-ranging and sometimes ambiguous assessment of the benthic community. RBP III offers a more rigorous evaluation of data, and allows detection of more subtle degrees of impairment to the aquatic community. By increasing the level of taxonomic resolution, that is, by performing taxonomic identification to the lowest practical level (genus/species), the ability to discriminate levels of impairment is greatly enhanced.

The macroinvertebrate collection procedure utilized kick-sampling, a method of sampling benthic organisms by kicking or disturbing bottom sediments and catching the dislodged organisms in a net as the current carries them downstream (Figure 2). Sampling was conducted throughout a 100 m reach, in riffle/run areas

with fast currents and cobble and gravel substrates—generally the most productive habitats, supporting the most diverse communities in the stream system. A kick net with an opening approximately 0.45 m wide and a mesh size of 590 μm was used to collect samples from a total area of approximately 2.0 m^2—ten 0.2025 m^2 kicks were taken at each station, then composited in the field and preserved with 95% ethanol before processing.

Where conditions were inappropriate for the collection of natural substrate samples, artificial substrate samplers were utilized. Artificial substrates, such as rock baskets or multiplate samplers, are especially useful in larger streams and rivers, or in streams lacking appropriate flow regimes and/or substrate types for kick sampling (Plafkin et al.1989). Artificial substrate samplers are also an ideal means of sampling because each sampler offers an identical area and substrate for colonization, and thus, a more standardized collection technique than kick sampling. Biological sampling in the mainstem Charles River, Mill River, and Bogastow Brook required artificial substrate sampler deployment. Hester-Dendy multiplate samplers were deployed as triplicates at each station. For the Mill River and Bogastow Brook stations, samplers were fastened horizontally to a 38 cm x 18 cm x 9 cm concrete block and placed on the streambed (Figure 3). At the Charles River stations above and below the Medfield POTW, multiplate samplers were suspended in the water column from buoys (Figure 4). Multiplates were deployed for a 6-8 week period, allowing for sufficient macroinvertebrate colonization. Upon retrieving samplers, each multiplate was submerged in a water-filled 1000 ml polyethylene bottle, and transported to the DWM biomonitoring laboratory where they were disassembled and rinsed, and organisms were picked and prepared (i.e., removed and preserved in 70% ethanol) for sample processing. Deployment of samplers by ENSR on the Charles River in the vicinity of the Milford WWTP/Milford Power Limited Partnership facilities was performed according to the procedures described in their Quality Assurance Project Plan (QAPP) (ENSR 1992) for the Charles River Monitoring Project. Upon collection, the samplers were preserved in 10% buffered formalin and shipped to Environmental Planning and Analysis in Tallahassee, Florida for species identification and enumeration. Analyses of data collected by ENSR were conducted by DWM.

Macroinvertebrate samples collected by DWM were processed in the DWM biomonitoring laboratory in Worcester, Massachusetts. A subsample of 100 organisms was separated from the original sample collected at each site, and specimens were identified to genus/species to the extent their condition allowed. Based on this taxonomy, various community, population, and functional parameters, or "metrics," were calculated which allow an investigator to measure important aspects of the biological integrity of the community. This integrated approach provides more assurance of a valid assessment because a variety of biological parameters are evaluated. Deficiency of any one metric should not invalidate the entire approach (Plafkin et al. 1989). Metric values for each station were scored based on comparability to the reference station, and scores were totaled. The percent comparability of total metric scores for each study site to those for a selected unimpaired reference station (i.e., "best attainable situation") yields an impairment score for each site. RBP III analysis separates sites into four categories: non-impaired, slightly impaired, moderately impaired, and severely impaired. Impairment of the benthic community may be indicated by the absence of generally pollution-sensitive macroinvertebrate taxa such as Ephemeroptera, Plecoptera, and Trichoptera (EPT); dominance of a particular taxon, especially the pollution-tolerant Chironomidae and Oligochaeta taxa; low taxa richness; or shifts in community composition relative to the reference station (Plafkin et al. 1989). Those biological metrics calculated and used in the analysis of Charles River watershed macroinvertebrate data are listed and defined below (For a more detailed description of metrics used to evaluate benthos data see Plafkin et al. 1989):

1. Taxa richness—a measure based on the number of taxa present. The lowest possible taxonomic level is generally assumed to be genus or species.

2. Chironomidae richness—is a count of the number of genera/species in the family Chironomidae (midges) found in the sample.

3. EPT Index—a count of the number of genera/species from the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). As a group these are considered three of the more sensitive aquatic insect orders. Therefore, the greater the contribution to total richness from these three orders, the healthier the community.
4. Biotic Index—based on the Hilsenhoff Biotic Index (HBI), is an index designed to produce a numerical value to indicate the level of organic pollution. Organisms have been assigned a value ranging from zero

to ten based on their tolerance to organic pollution. A value of zero indicates the taxon is highly intolerant of pollution and is likely to be found only in pollution free waters. A value of ten indicates the taxon is tolerant of pollution and may be found in highly polluted waters. The number of organisms and the individually assigned values are used in a mathematical formula that describes the degree of organic pollution at the study site. The formula for calculating HBI is:

$$HBI = \sum \frac{x_i t_i}{n}$$

5. Shannon Diversity Index—more accurately referred to as the Shannon-Weiner Diversity Index, is an index derived from evenness and richness combined in a mathematical formula to produce a general index of diversity.

6. Evenness—is a measure of the relative abundance of the taxa in the sample and how evenly distributed the taxa are in the sample. The greater the value, the more evenly distributed are the taxa.

7. Total abundance—is the number of individual organisms found in a given sample (or subsample). Under certain types of stresses, standing crops (i.e., numbers) may increase or be reduced (Resh and Jackson 1993).

8. Ratio of EPT and Chironomidae Abundance—The EPT and Chironomidae abundance ratio uses relative abundance of these indicator groups as a measure of community balance. Skewed populations having a disproportionate number of the generally tolerant Chironomidae relative to the more sensitive insect groups may indicate environmental stress.

9. Percent Contribution Dominant taxon—is the ratio of the dominant taxon (genus or species) to the total count in the sample. This ratio is an indication of community balance. If the ratio is high, then the community is dominated by few species, indicating environmental stress. Conversely, if the ratio is low, then there is more balance among species, indicating a healthy community.

10. Ratio of Scraper and Filtering Collector Functional Feeding Groups—this ratio reflects the community food base. The proportion of the two feeding groups is important because predominance of a particular feeding type may indicate an unbalanced community responding to an overabundance of a particular food source (Plafkin et al. 1989).

11. Community Similarity—is a comparison of a study site community to a reference site community. Similarity is often based on indices that compare community composition. Most community similarity indices compare richness and/or richness and abundance. Generally speaking, communities will become more dissimilar as stress increases.

For those stations where multiplate samplers were used, mean metric values for downstream study-site samplers were compared to those for the upstream control site using Student's t-test. The t-test's assumption of equal population variances (homoscedasticity) was determined to be met after performing a variance ratio test, for which one calculates

$$F = \frac{s^2_1}{s^2_2} \text{ or } \frac{s^2_2}{s^2_1}, \text{ whichever is larger}$$

where F is the calculated ratio of sample variance; s^2_1 is the variance of sample 1; s^2_2 is the variance of sample 2. A calculated F value which is less than critical F at 0.05 significance leads to an acceptance of H_o (i.e., the variances of the two populations are equal), which was always the case with the multiplate samples in this study. The Student's t-test then, which tests the null hypothesis that the difference between two means is equal to zero, was performed as follows:

$$t = \frac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{[(s_1)^2/n^2] + [(s_2)^2/n^1]}}$$

where $\bar{x}_1 - \bar{x}_2$ is the difference between the two means; $(s_1)^2$ is the variance of population 1 ; $(s_2)^2$ is the variance of population 2; n^1 is the number of samples in population 1; n^2 is the number of samples in population 2. A calculated t-statistic (t) greater than the critical magnitude, which is determined after defining the critical regions for t with $(n^1 + n^2 - 2)$ degrees of freedom, leads to a rejection of H_o. The t-statistic values are then used as the basis for evaluation of impairment, which is determined using "best professional judgement."

Another important assumption of the parametric Student's t-test is that the populations being compared are normally distributed. This assumption may be untenable in the case of the Mill River, Bogastow Brook, and Charles River multiplate assemblages, especially due to a relatively small sample size (3 replicates) at each station. The Mann-Whitney Test is one of the most powerful *non-parametric* tests, and can be a useful alternative to the t-tests and their assumptions of normality (Zar 1984). As with the Student's t-test, then, the Mann-Whitney Test was used to compare metric means of the downstream Mill River samplers to their upstream control samplers, the downstream Charles River samplers to their upstream control, and the downstream Bogastow Brook samplers to their upstream control. The statistic is calculated as follows:

$$U = n_1 n_2 + \frac{n_1(n_1 + 1)}{2} - R_1$$

where n_1 and n_2 are the number of observations in samples 1 and 2, respectively, and R_1 is the sum of the ranks of the observation in sample 1. If U is found to be as great or greater than the critical value at 0.05 significance, the null hypothesis (i.e., the two means are equal) is rejected. Because non-parametric tests are "less powerful" than parametric tests such as the Student's t-test, and because the t-test may be "robust" to minor violations of their assumptions, results of the Mann-Whitney Tests performed on the multiplate data will be used in conjunction with—rather than as an alternative to—results of Student's t-tests performed on the same data. Results from both parametric and non-parametric tests on the macroinvertebrate data, then, should be most convincing if they agree with each other, and should enhance the ability to make valid assessment decisions concerning impairment to the aquatic community at a given study site.

In addition to metric mean comparisons using Student's t-test and the Mann-Whitney Test at the Mill River (MR01, MR02) and Bogastow Brook (BB04, BB04A) stations, ordination analysis was conducted for similarities calculated from the coefficient of community (cc) index (as described by Beckett 1978) for the macroinvertebrate assemblages present. The cc index was compared both among triplicate samplers and between triplicate samplers, and compares community composition by the formula:

$$cc = \frac{2s_{ab}}{s_a + s_b}$$

where s_a is the total number of taxa in each sample "a"; s_b is the total number of taxa in sample "b"; and s_{ab} is the number of taxa common to both samples. The taxa present on each multiplate sampler were thus compared against those on each of the other samplers, and these results were then placed in a data matrix. The columns for the pairing yielding the highest value (1.0 = complete similarity, 0 = complete dissimilarity) were combined and divided by two. The new value was then entered, under the combined heading, into a new matrix. This procedure was repeated until the order of simmilarity had been determined for all the samples.

RBP III also utilizes a habitat assessment matrix for rating habitat quality, an integral component in the final evaluation of impairment. The habitat assessment is intended to support the biosurvey and enhance the interpretation of the biological data. The matrix used to assess habitat quality is based on key physical characteristics of the water body and surrounding land use. Most parameters evaluated are instream physical attributes often related to overall land use and are potential sources of limitation to the aquatic biota (Plafkin et al. 1989). The ten habitat parameters are as follows: instream cover, epifaunal substrate, embeddedness, sediment deposition, velocity/depth combinations, channel flow status, right and left (when facing downstream) bank vegetative protection, right and left bank stability, right and left bank riparian vegetative zone width. Habitat parameters are scored, totaled, and compared to a regional reference station and/or a site-specific control (upstream reference) station to provide a final habitat ranking.

Macroinvertebrate biomonitoring was conducted at 5 stations (Table 1) based on modifications to the RBP I protocol, a screening or reconnaissance assessment that documents specific visual observations made in the field by a trained professional. The RBP I procedure was used at these stations due to habitat and flow constraints that made the application of the RBP III methodology impractical. RBP I is used to discriminate obviously impacted and non-impacted areas from potentially affected areas. A biosurvey component focuses on qualitative sampling of benthic macroinvertebrates, supplemented by a preliminary field examination of other aquatic biota (periphyton, macrophytes, and fish). Qualitative benthic samples are collected from all available habitats using a kick net; Benthic macroinvertebrate orders/families are listed on a field data sheet. As with RBP III, an evaluation of habitat is conducted using the same assessment matrix as RBP III. On the basis of the observations made on habitat, water quality, physical characteristics, and the qualitative biosurvey, the investigator determines whether impairment is detected.

Fish and Periphyton Population Assessments

Fish and periphyton population data were collected to supplement the macroinvertebrate biomonitoring data. Collection methods used to assess fish populations followed a modified version of RBP Protocol V (Plafkin et al. 1989) and were conducted by DWM biologists. The data analysis techniques, however, were qualitative only, as low diversity typical of the region precluded the use of biological indices for community analyses. Periphyton community assessments were qualitative as well, with DWM biologists conducting sampling and appropriate analyses. Periphyton sampling was conducted at ten macroinvertebrate kick sampling stations: Stop River (SR03), Stony Brook (ST01), Rosemary Brook (RB01), Trout Brook (TB01), Beaver Brook (BE02), Waban Brook (WB01), and Fuller Brook (FB02). Fish sampling using a Smith-Root model backpack shocker was limited to only five stations due to habitat constraints: Alder Brook (AB01), Stony Brook (ST01), Rosemary Brook (RB01), Powissett Brook (PB01) and Trout Brook (TB01)—all streams are previously "unassessed" by DEP for fish population data.

PERIPHYTON

Periphyton samples were collected in order to learn more about the biota in the streams and rivers, to document problem areas, to offer a means of comparing biological communities, to examine community changes, and to provide a record of the taxa that are found in Massachusetts.

Materials and Methods

Sampling was typically performed in an open-canopy riffle area. The sampling consisted of scraping rock and cobble substrates with a knife and collecting the material in a labeled glass vial. The samples were kept in an iced cooler and transported to the DWM laboratory in Worcester for identification.

A vial was shaken to get a uniform sample before sub-sampling. If filamentous algae comprised most of the sample they were removed first, identified separately and then the remainder of the sample was examined. An Olympus BH2 compound microscope with Nomarski optics was used for the identifications. Slides were typically examined under 200 power. A modified method for periphyton analysis developed by L. Bahls (1993) was used. Only the "soft-bodied" periphyton were ranked according to their relative abundance and identified to genus. The soft-bodied algae are the green and blue-green algae. They do not require cleaning with acid in order to determine their identifying characteristics. The diatoms are algae with a protective shell of silica and must be treated with acid before they typically can be identified to genus or species. Because of the additional time and skills needed for their taxonomic work, the diatoms were only enumerated as class Bacillariophyceae. The scheme developed by Bahls for determining abundance is:

R (rare)	fewer than one cell per field of view at 200x, on the average;
C (common)	at least one, but fewer than five cells per field of view;
VC (very common)	between 5 and 25 cells per field;
A (abundant)	more than 25 cells per field, but countable;
VA (very abundant)	number of cells per field too numerous to count.

Analysis

The periphyton work afforded a qualitative assessment of instream water quality and habitats based on species composition and estimates of biomass. The information described above is critical for the determination of instream dominance. However, dominance alone does not provide all the information necessary to evaluate the impacts of algal growth on a stream. Information on the habitat and on the algal coverage is also helpful. The current field collection methods do not include quantitative assessment of algal cover. Any indication of the extent of algal cover in a particular reach is based on an estimate made during the habitat assessment. Areas with extensive algal growth are certainly identified in this manner, but areas in transition maybe overlooked. This does limit the usefulness of the data; therefore, the analysis is limited to general comments regarding a particular site. They may also take into account comparative observations with other streams and habitats.

FISH

Materials and Methods

Fish community (RBP V) sampling was conducted by DWM at each station using a battery-powered backpack electroshocking unit (Smith Root Model 12). One pass was made in a representative stream reach (containing riffle, run, and pool habitat when available) measuring approximately 100 meters. Fish sampling commenced at the downstream riffle or other barrier (e.g., seine net, culvert, etc.) and proceeded upstream in side-to-side sweeps. Sampling was terminated at a constriction or other barrier to migration (such as a net) at the upstream end of the reach. Attempts were made to pick up all fish (except young-of-the-year) observed. All fish collected were held in plastic buckets for identification, enumeration, and subsequent release. Voucher specimens were retained and preserved for later verification if field identifications were questionable.

Analysis

The RBP V protocol (Plafkin et al. 1989) calls for the analysis of the data generated from fish collections using an established Index of Biotic Integrity (IBI) similar to that described by Karr et al. (1986). Since no formal IBI exists for Massachusetts surface waters, the data provided by this sampling effort was used to assess the general condition of the resident fish population as a function of abundance and diversity.

Table 1. List of macroinvertebrate biomonitoring station locations for the 1997 Charles River watershed biomonitoring survey, including station number, station description, survey date, and sampling protocol used.

STATION	SITE DESCRIPTION	SAMPLING DATE	METHOD
CR03	Charles River, dnst. fr. Walker St., Medway MA	9 July 1997	RBPIII-kick
CR04	Charles River, dnst. fr. Dean St., Millis MA	9 July 1997	RBPIII-kick
CR00	Charles River, dnst. fr. Watertown Dam, Watertown MA	5 July 1997	RBPIII-kick
SR01	Stop River, dnst. fr. Pine St., Norfolk MA	8 July 1997	RBPIII-kick
SR02	Stop River, dnst. fr. Campbell St., Norfolk MA	8 July 1997	RBPIII-kick
SR03	Stop River, dnst. fr. Noon Hill Av., Norfolk MA	8 July 1997	RBPIII-kick
ST01	Stony Brook, dnst. fr. Church St., Weston MA	15 July 1997	RBPIII-kick
TB01	Trout Brook, dnst. fr. Haven St., Dover, MA	16 July 1997	RBPIII-kick
RB01	Rosemary Brook, dnst. fr. Barton St., Wellesley MA	16 July 1997	RBPIII-kick
FB02	Fuller Brook, upst fr. Cameron St., Wellesley MA	21 August 1997	RBPIII-kick
AB01	Alder Brook, dnst. fr. South St., Needham MA	16 July 1997	RBPIII-kick
PB01	Powissett Brook, dnst. fr. Wilsondale Rd., Dover MA	16 July 1997	RBPIII-kick
BE02	Beaver Brook, dnst. fr. Trapelo Rd., Belmont MA	17 July 1997	RBPIII-kick
MB02	Mine Brook, dnst. fr. Route 140, Franklin MA	8 July 1997	RBPIII-kick
JB01	Jar Brook, upst. fr. Travis Rd., Holliston MA	10 July 1997	Qualitative
DB01	Dopping Brook, dnst. fr. Brook St., Holliston MA	10 July 1997	Qualitative
RM01	Rock Meadow Brook, upst. fr. Summer St., Westwood MA	16 July 1997	Qualitative
WB01	Waban Brook, dnst fr. Route 16, Wellesley MA	21 August 1997	Qualitative
CB01	Cheese Cake Brook, near mouth, Newton MA	28 January 1997	Qualitative
CR05	Charles River, upst. fr. West St., Medfield MA	11 July - 3 September 1997	RBPIII-multiplates
CR06	Charles River, dnst. fr. West St., Medfield MA	11 July- 3 September 1997	RBPIII-multiplates
BB04	Bogastow Brook, dnst. fr. Fiske St., Holliston MA	10 July- 21 August 1997	RBPIII-multiplates
BB04A	Bogastow Brook, upst. fr. Central St., Holliston MA	10 July- 21 August 1997	RBPIII-multiplates
MR01	Mill River, dnst. fr. Main St., Norfolk MA	9 July- 2 September 1997	RBPIII-multiplates
MR02	Mill River, dnst. fr. Miller St., Norfolk MA	9 July- 2 September 1997	RBPIII-multiplates
REACH 1*	Charles River, dnst. fr Howard St., Milford MA	17 August- 24 September 1997	RBPIII-multiplates
REACH 2*	Charles River, dnst. fr Howard St., Hopedale MA	17 August- 24 September 1997	RBPIII-multiplates
REACH 3*	Charles River, dnst. fr Mellen St., Hopedale MA	17 August- 24 September 1997	RBPIII-Multiplates

* Macroinvertebrate sampling and habitat assessments conducted by ENSR Consulting and Engineering.

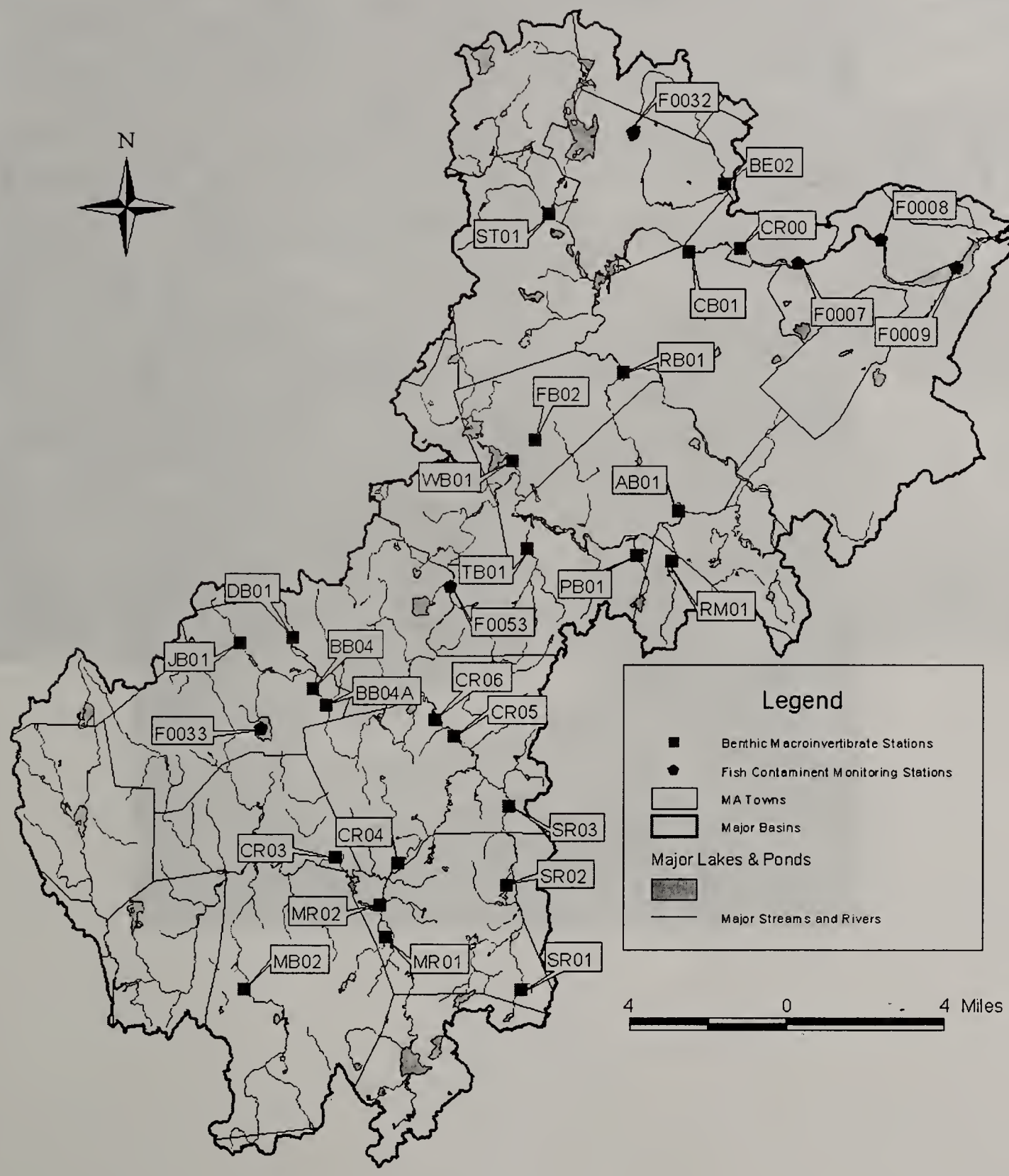

Figure 1. Location of DWM biomonitoring stations sampled during the 1997 Charles River watershed survey.

Figure 2. DEP biologist collecting macroinvertebrates using the "kick sampling" technique.

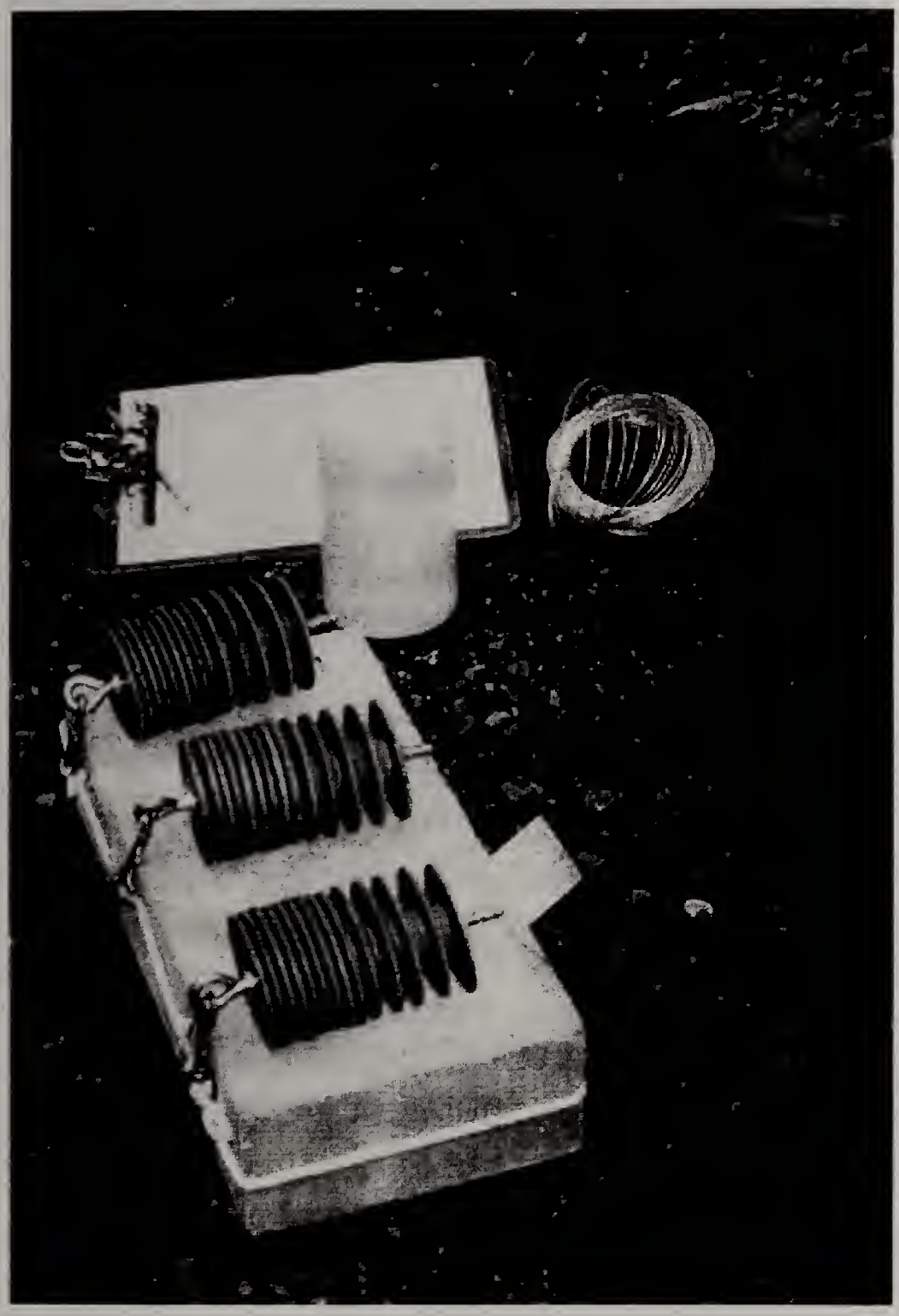

Figure 3. Multiplate samplers for shallow water deployment.

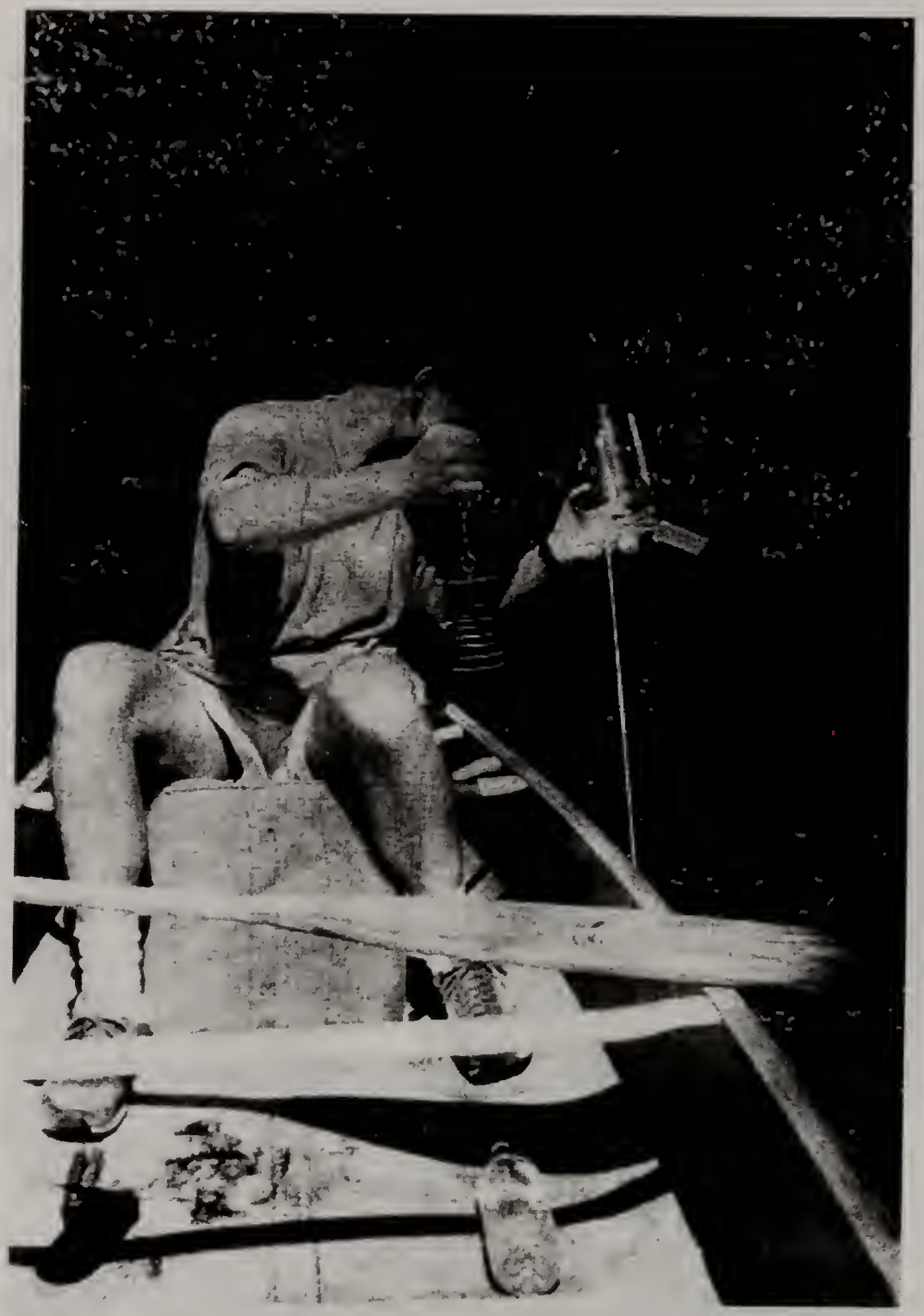

Figure 4. *Deployment of multiplate samplers in deep water.*

RESULTS & DISCUSSION

Taxonomic lists of macroinvertebrates collected from each biomonitoring station are attached as an appendix (Appendix A). Table A1 includes the genus/species level taxa list for those stations where kick sampling was conducted. Included in the taxa list is total organism counts at each station based on a 100 organism subsample, and the fuctional feeding group (FFG) and tolerance value (TV) of each taxon. Table A2 includes the genus/species level taxa list for those stations where the macroinvertebrate collection procedure utilized Hester-Dendy artificial substrate samplers. Unless noted, organism counts at each station are based on 100 organism subsamples. Also included in Table A2 are the FFG and TV of each taxon present. Table A3 is the family level taxa list for those stations where sampling was conducted qualitatively. The taxa list is merely a list of those organisms represented at a particular station (presence is indicated with an "X"). Also included is the TV for each taxon present, as well as its FFG designation.

Summary tables for the macroinvertebrate data analyses, including biological metric calculations, metric scores, and impairment scores for each station, are included in Appendix B. Tables B1 and B3 are the data analysis (based on Student's t-tests and Mann-Whitney Tests) summaries for those stations in which artificial substrate samplers were used to address low flow issues in Bogastow Brook and Mill River respectively. Tables B2 and B4 include the data matrices resulting from the ordination of similarities calculated and compared for the Bogastow Brook and Mill River stations respectively. Dendrograms were created (Figures B1 and B2) to better illustrate the relative similarity of the Bogastow Brook and Mill River multiplate communities respectively, the horizontal bars indicating the similarity between each cluster and each successive sample or cluster. Beckett (1978) suggests that a cc index value of ≥ 0.65 be used as a guide for recognizing highly similar clusters. Ideally, it would be expected that each of the triplicate samples at a given station would be highly similar (≥ 0.65) and likely more similar to each other than to those from another site. Tables B5 and B6 are the data analysis (based on Student's t-tests and Mann-Whitney Tests of data collected by ENSR) summaries for those stations in which artificial substrate samplers were used to address point source pollution issues on the Charles River in the vicinity of the Milford WWTP/Milford Power Limited Partnership facilities. Table B7 is the data analysis (based on metric scoring—lost multiplates precluded the comparison of macroinvertebrate data using statistics) summary for those stations in which artificial substrate samplers were used to address point source pollution issues on the Charles River in the vicinity of the Medfield POTW. Tables B8 through B10 are the data analysis (based on metric scoring) summaries for those stations where kick sampling was utilized to address point source issues on Stop River and the Charles River respectively, and nonpoint source pollution issues in the tributaries and mainstem of the watershed. Habitat assessment scores for each station are also included in the data analysis summary tables.

Appendix C includes a more detailed summary of the habitat evaluation for each biomonitoring station (Table C1). Scores for individual habitat parameters are included, as well as the total habitat assessment score. The highest total score a station may receive is 200. Appendix C also includes the taxa list for fish collected at five biomonitoring stations (Table C2), and a list of periphyton taxa and abundance—and associated habitat information—present at selected macroinvertebrate kick sampling stations (Table C3).

Groundwater Withdrawals/Flow Reduction

Bogastow Brook (BB04 and BB04A): Hester-Dendy artificial substrate samplers deployed 10 July 1997; retrieved 21 August 1997.

BB04—Bogastow Brook, Holliston, MA

HABITAT

The BB04 reach began approximately 200 m downstream from Fiske Street in Holliston; however, rather than sampling throughout the 100 m reach, artificial substrate samplers—arranged as triplicates (BB04-1; BB04-2; BB04-3)—were placed approximately midreach at a depth of about 0.75 m. This portion of the stream was about 3 m wide with a depth of approximately 1 m. Much like the rest of Bogastow Brook, the BB04 reach was characterized by a slow moving, meandering channel dominated by wetland vegetation throughout its riparian zone. Instream substrates of sand and finer sediments—typical of low gradient streams—appeared to shift frequently, forming depositional bars at the bends and constrictions in the channel. Road runoff from

the upstream crossing may contribute to observed sedimentation in the BB04 reach. The lack of hard, large substrates resulted in poor fish and macroinvertebrate habitat, although the dense beds of aquatic vegetation (*Potamogeton* sp., *Peltandra* sp.) probably provided some cover for fish and minimal microhabitat for macroinvertebrates. Both stream banks were very stable, and a wide riparian zone dominated by grasses (*Poa* sp.), shrubs (*Cornus stoloniferous*, *Cephalanthus occidentalis*), and herbaceous growth (*Peltandra virginica*, *Onoclea sensibilis*) provided a good buffer from human perturbations. Significant patches of nonnative purple loosestrife (*Lythrum salicaria*) and common reedgrass (*Phragmites* sp.), however, suggest past disturbances, and some commercial development now exists adjacent to the stream. BB04 received a habitat assessment score of 113 out of a possible 200 (Table C1).

BB04 was designated the upstream control for BB04A, and was located approximately 1000 m upstream of a groundwater well serving as a public water supply (2136000-05G) for the town of Holliston. Flow measurements taken on 8 July 1997 found this portion of the stream to discharge at a rate of 1.09 cubic feet per second (cfs).

BENTHOS

Metric values for each triplicate sampler at BB04 are included in Table B1. Ordination analysis of community similarities for macroinvertebrate on multiplate samplers at BB04 found BB04-1 and BB04-2 samplers to be highly similar (Figure B1). The macroinvertebrate assemblage on the BB04-3 multiplate, however, was less similar to those on BB04-1 and BB04-2 (i.e., actually more similar to BB04A assemblages). All of the BB04 multiplate communities were dominated by relatively few taxa. High densities of the amphipod *Gammarus* sp. and the isopod *Caecidotea communis* (Table A1) were not surprising, as these crustaceans have been shown to prefer slow-moving waters (Beckett and Miller 1982). Also abundant was the chironomid *Tanytarsus* sp. (Table A1), whose high tolerance of organic pollution contributes greatly to the mean biotic index of 6.80 at this station. The somewhat low EPT index—which summarizes the taxa richness within the insect groups considered most pollution sensitive—is probably at least partially a function of flow regime at BB04, as these insect orders generally favor the riffle areas of swift-moving streams. The mayfly *Stenacron* sp. was fairly well-represented on all three triplicate samplers (Table A1); however, the high tolerance value for this taxon is uncharacteristic of the Ephemeroptera order.

BB04A—Bogastow Brook, Holliston, MA

HABITAT

The BB04A sampling reach began approximately 300 m upstream from Central Street in Holliston, and was located about 700 m downstream from the groundwater well. The sampling reach was very similar to the BB04 station—slow moving and meandering through an extensive riparian zone dominated by wetland vegetation. Instream substrates were characterized by sand and finer sediments, with occasional snags and woody debris serving as the only hard substrates for macroinvertebrate colonization and fish cover. Beds of aquatic vegetation, particularly rooted emergent forms (*Peltandra virginica*, *Sparganium* sp.), and rooted submergents (*Nasturtium* sp.) provided additional cover for observed small fish. The wide blades of instream burreed (*Sparganium* sp.) also provided filter-feeding invertebrates, such as the black fly larva *Simulium* sp. with a good attachment site. A wide and undisturbed riparian zone was interspersed with a fern-dominated (*Onoclea sensibilis*, *Osmunda regalis*, *Thelypteris palustris*) herbaceous layer and a shrub layer of *Cornus stoloniferous* and *Cephalanthus occidentalis* before reaching a maple-dominated (*Acer rubrum*) forest. Nonnative vegetation was much less abundant here than at the upstream BB04 station. BB04A received a habitat assessment score of 131—considerably higher than the upstream control station (Table C1). A more stable and diverse fish habitat, and much less sediment deposition at BB04A, accounts for the difference in habitat with BB04.

Flow measurements, taken on 8 July 1997, found this segment of Bogastow Brook to discharge at a rate of 2.14 cfs, which was higher than the discharge upstream from the groundwater withdrawal.

BENTHOS

Metric values for each triplicate sampler at BB04A are included in Table B1. Ordination analysis of community similarities for macroinvertebrate on multiplate samplers at BB04A found all three triplicate

samplers to display fairly similar assemblages (Figure B1). In particular, BB04A-1 and BB04A-3 assemblages were highly similar to each other, with a cc index of 0.65. The cc index of 0.51 indicates that BB04A triplicates were not highly similar to the most similar BB04 multiplate assemblages. While the isopod *Caecidotea communis* and the chironomid *Tanytarsus* sp. were again common, a different amphipod (*Hyalella azteca*), the mayfly *Paraleptophlebia* sp., and the predatory megalopteran *Sialis* sp., were fairly well-represented on the BB04A triplicate samplers and probably account for the dissimilar cc index values to BB04 (Table A1). Results of both Student's t-test and Mann-Whitney Test found no significant difference in five of the seven metric value means between BB04 and BB04A samplers (Table B1). The biotic index, which both statistical tests found to be significantly different between the two stations, was actually lower for the BB04A multiplate assemblages. The biotic index summarizes the various tolerances of the benthic community with a single value, and decreases in value as water quality increases. The Student's t-test and Mann-Whitney Test also found community similarity at BB04A to differ significantly from the BB04 multiplate assemblages (Table B1)—corroborated by the ordination analysis results just mentioned.

The aquatic community at BB04A was determined to be nonimpaired (Table B1). Most metrics values were not found to differ from those for the upstream control station. Values for those attributes that measure components of community structure (taxa richness, biotic index, and EPT index)—which display the lowest inherent variability among the RBP metrics used (Resh 1988)—were similar to, or in the case of the biotic index, better than those for BB04. And the macroinvertebrate assemblages found on the BB04A multiplates, while somewhat dissimilar to those at BB04, were in fact represented by more pollution-sensitive taxa.

It appears, then, that the groundwater well adjacent to Bogastow Brook may not be adversely affecting aquatic life, at least in the stream segment immediately downstream of the water withdrawal. Corroborating this conclusion are minimal or no impairment to the BB04A benthic community, instream and riparian habitats considered better than the upstream control station, and a discharge rate higher than that at the control station. However, additional benthos data collections/comparisons over the next several years may be more revealing and are recommended before making a definitive assessment of water withdrawal impacts in this stream. The macroinvertebrate communities found at the BB04 and BB04A stations may, in fact, better reflect the water quality conditions there rather than water quantity conditions. Bacteria samples taken on 19 August 1997, found fecal coliform levels at BB04 (600 colony forming units/100 ml) to be twice as high as at BB04A and exceeding the Class B water quality standard of 200/100 ml. The BB04 station is not far downstream from one of many Holliston housing subdivisions with suspected septic system failures. This apparent water quality impairment at the BB04 reference station may, in fact, interfere with the detection of reduced flow impacts downstream from BB04A.

Mill River (MR01 and MR02): Hester-Dendy artificial substrate samplers deployed 9 July 1997; retrieved 2 September 1997.

MR01—Mill River, Norfolk, MA

HABITAT

The sampling reach began approximately 250 m downstream from Main Street and City Mills Pond in Norfolk. MR01 serves as the upstream control for MR02, and together the two stations will provide a "pre-implementation assessment" of aquatic integrity above and below the proposed Mill River Well. Upstream-downstream comparisons of aquatic health—which currently are expected to be similar, will ideally be made again during the next monitoring phase ("year 2") of the basin cycle for the Charles River watershed, which will occur in 2003.

The MR01 reach was an open-canopied, low gradient portion of Mill River that emerges from a hardwood forest before meandering through an extensive wetland area. Although the stream was fairly shallow with good velocity and diverse instream substrates just upstream of MR01, the sampling reach was dominated by soft substrates and flow regimes characteristic of other low gradient streams in the watershed. Stream width at MR01 was approximately 4 m, with a fairly uniform depth of about 0.75 m. The lack of hard substrates and velocity/depth combinations provided poor habitat for invertebrates, although a mix of snags and other woody debris provided fish with good cover. Occasional instream beds of rooted submergent vegetation (*Elodea* sp, *Myriophyllum* sp., *Callitriche* sp.) and filamentous green algae were found throughout the sample reach, while

grass (*Poa* sp., *Phragmites australis*) and burreed (*Sparganium* sp.) dominated the vast riparian zone. Elm (*Ulmus* sp.) and red maple (*Acer rubrum*) were scattered throughout the riparian zone, but decreased in abundance downgradient of the reach. While there was no obvious evidence of nonpoint source pollution inputs, considerable amounts of trash (old bottles, scrap metal) were found in the stream. MR01 received a habitat assessment score of 123 (Table C1). Flow measurements, taken on 9 July 1997, found this portion of the stream to discharge at a rate of 4.14 cfs.

BENTHOS

Metric values for each triplicate sampler at MR01 are included in Table B3. Ordination analysis of community similarities for macroinvertebrate on multiplate samplers at MR01 found MR01-2 and MR01-3 assemblages to be highly similar, while the MR01-1 macroinvertebrate assembage was less similar to the other two (Figure B2). While the amphipod *Gammarus* sp. was well- represented on all three samplers, more than half of the triplicate assemblages were dominated by the mayflies *Stenonema* sp. and *Trichorythodes* sp.—generally considered rheophilic forms, as their external gills are dependent on current for respiration (Table A1).

MR02—Mill River, Norfolk, MA

HABITAT

The MR02 triplicate samplers were deployed approximately 15 m downstream from Miller Street in Norfolk, and roughly 1200 m downstream from the proposed Mill River Well site. This portion of the stream slowly meanders through extensive wetlands before joining with the Charles River at the Norfolk/Millis border. Stream width at MR02 (6 m) was slightly greater than the MR01 station, while depth was similar at 0.75 m. Overall habitat at MR02 was comparable to the upstream control. Fine sediments and low current velocities provided poor epifaunal substrates for macroinvertebrate colonization. Instream cover for fish was somewhat limited, with much less woody material than at the MR01 station. Watermilfoil (*Myriophyllum* sp.) comprised most of the rooted submergent vegetation, while arrowhead (*Saggitaria* sp.), smartweed (*Polygonum* sp.,) and burreed (*Sparganium* sp.) were well-represented emergent forms. The riparian zone offered a wide vegetative buffer along the left (west) bank, and was comprised mainly of grasses (*Poa* sp., *Phragmites australis*), purple loosestrife (*Lythrum salicaria*), and multiflora rose (*Rosa multiflora*). Dogwood (*Cornus* sp.) and red maple (*Acer rubrum*) trees were sparsely scattered throughout the zone. The right (east) bank riparian zone was similar to the left (west), although only a narrow vegetative buffer of grasses and shrubs existed adjacent to the sampler deployment site, where Miller Street briefly runs close to the stream before veering away. The potential for NPS inputs in the form of road runoff is highest at this point and just upstream at the Miller Street crossing.

MR02 received a habitat assessment score of 119, which was highly comparable to the evaluation for the upstream control station (Table C1). Flow measurements, taken on 9 July 1997, found this portion of Mill River to discharge at a rate of 6.13 cfs.

BENTHOS

Metric values for each triplicate sampler at MR2 are included in Table B3. Ordination analysis of community similarities for macroinvertebrate on multiplate samplers at MR02 found MR02-2 and MR02-3 assemblages to be fairly similar, while the MR02-1 macroinvertebrate assembage was less similar to MR02-2 and MR02-3 (Figure B2). All three triplicate samplers supported communities dissimilar to those found on the MR01 samplers. The numerical dominance of the amphipod *Hyalella azteca* and the isopod *Caecidotea communis* (Table A1) no doubt contributes to the high biotic index values for the MR02 triplicate assemblages, which are significantly different than those for the MR01 triplicate assemblages (Table B3). Other metric values which were significantly different from those for the MR01 assemblages are EPT/Chironomidae, and community similarity (Table B3). The three diversity metrics, however, were not significantly different from upstream values, nor was the percent dominant taxon metric value (Table B3). The scraper/filterer metric value was not significantly different from the MR02 mean value when using the Student's t-test. However, the Mann-Whitney Test—which is a less robust, yet, more conservative analysis of the benthos data—did show a significant difference between these metrics (Table B3).

Significant differences in community structure and metric values between the MR02 multiplate assemblages and those at MR01 were somewhat unexpected, and reasons for these discrepancies are not completely clear. The apparent displacement of pollution-sensitive rheophilic macroinvertebrates by numerous slow-water forms, relative to the upstream station, may be a function of flow regimes. Current velocities measured at MR02 averaged 0.22 feet per second (fps), while velocity at the MR01 station was 0.72 fps. In addition, instream and riparian habitat—which was considered similar at both multiplate sites, was markedly different just upstream of each station. The forested stream system just upstream of MR01 may offer different food resources to the immediate downstream aquatic community than at MR02—which is surrounded by a vast expanse of open-canopied wetland and may support a somewhat different trophic guild.

Despite significant differences in some of the metric values between the MR02 and MR01 multiplate assemblages, MR02 was considered only slightly impaired. Diversity indices comparable to upstream control values, and an invertebrate assemblage typical of its surrounding habitat, corroborate this assessment. Water quality samples collected by CRWA on 17 October 1996 found all parameters—conductivity, BOD, pH, dissolved oxygen, fecal coliform levels, and total suspended solids—well within Massachusetts surface water quality standards (CRWA 1997). It is recommended that the EOEA Charles River Basin Team conduct a site visit of the new housing subdivision located between the MR01 and MR02 stations and adjacent to the Mill River system, as this is a potential source of NPS inputs between the two sampling reaches.

Mine Brook (MB01 and MB02): RBP III-kick sampling conducted 8 July 1997 at MB02 only.

MB01—Miscoe Brook, Franklin, MA

HABITAT

Miscoe Brook serves as the headwater stream for the Mine Brook sub-watershed, which drains an area of 16.32 square miles in Franklin, the fastest growing town in Massachusetts. The MB01 station is located at Washington Street, a short distance upstream of where Miscoe Brook and Dix Brook converge to form Mine Brook. Macroinvertebrate sampling at MB01 was proposed to provide baseline benthos data downstream from the proposed State Forest Well. MB01 was also to serve as an upstream control for MB02, bracketing numerous groundwater wells throughout the aquifer underlying and adjacent to Mine Brook. However, minimal flows throughout Miscoe Brook made biological and habitat assessments at MB01 impossible. Flow measurements, taken on 9 July 1997, found this portion of the stream to discharge at a rate of 0.16 cfs.

Because flow and habitat constraints precluded the use of an upstream control in assessing potential low-flow impacts to the downstream communty at MB02, the regional reference station ST01 was used to represent "best attainable conditions" relative to the entire watershed. While upstream-downstream comparisons (i.e., site-specific approach) are more appropriate for an assessment of a known or perceived impact source (Plafkin et al. 1989), the regional reference approach should still provide a valid assessment of present conditions at the MB02 study site based on comparability to the natural habitat and "least impacted conditions" of the region. In addition, the sampling approach should help in making more general assessments of anthropogenic impacts such as nonpoint source pollution, although it may not "discriminate" low flow effects from nonpoint source pollution effects in the Mine Brook system. A complete description of the habitat and benthic community observed at ST01 is discussed later in this report, as it served as the regional reference station for a number of tributary study sites in the watershed.

MB02—Mine Brook, Franklin, MA

HABITAT

The MB02 sampling reach began approximately 100 m downstream of Route 140 in Franklin. Although much of Mine Brook is characterized by a slow moving channel bordered by wetland vegetation, this portion of the stream had a variety of flow regimes, adequate gradient, and diverse instream substrates. Instream bryophyte cover contributed to productive microhabitat for macroinvertebrates. While the undisturbed riparian zone along the right (east) bank was well vegetated with shrubs (*Vitis riparia*, *Celastrus scandens*, *Alnus* sp., *Viburnum* sp., *Parthenocissus quinquifolia*) and trees (*Fraxinus americana*, *Acer rubrum*, *Ulmus rubra*), the left (west) bank riparian zone was very narrow, offering minimal protection from NPS inputs from the adjacent

road. As a result, considerable amounts of trash and sediment were observed instream, no doubt originating from the poorly buffered left bank and the adjacent road. Runoff from the upstream road crossing was also an obvious source of NPS pollution, contributing to moderate levels of instream embeddednes and deposition. In addition, severe channelization upstream from the sampling reach (the result of a mill) may impact habitat quality at MB02. MB02 received a total habitat assessment score of 136 out of a possible 200 (Table C1). Flow measurements taken on 9 July 1997 found this portion of Mine Brook to discharge at a rate of 1.08 cfs.

BENTHOS

The benthic community at MB02 supported a fairly diverse assemblage of macroinvertebrates relative to the reference station at ST01 (Table B10). Although the EPT index metric scored poorly compared to the reference station, an index of 8 was higher than all other "kick" sampling biomonitoring stations in the Charles River watershed (Table B10). In general, the MB02 sampling reach appears to support a fairly well-balanced community, and the series of impoundments upstream do not seem to contribute excessive amounts of fine particulate organic material (FPOM). The lack of an overly dominant taxon and a high ratio of scrapers/filterers corroborate the apparent balance in community and trophic structure. MB02 received a total metric score of 28, which was 70% comparable to the "best attainable conditions" of ST01. The slight impairment to the aquatic community is probably the result of habitat impacts rather than water quality degradation. Reduced substrate microhabitat due to embeddedness and sediment deposition is the most likely cause of the suppressed EPT community at MB02, as these forms may be susceptible to increases in sediment loading due to their inability to burrow (Johnson et al. 1993).

Due to the inability to establish baseline reference conditions (i.e., lack of an appropriate upstream control) upstream from water withdrawals in the Mine Brook aquifer, it was difficult to discern the impacts of reduced flows on biological integrity in the Mine Brook system. However, the benthos data collected during the 1997 biosurvey should provide useful baseline biological conditions for monitoring trends in benthic community structure over time, particularly relating to the imminent increases in public groundwater withdrawals in this sub-basin.

Dopping Brook (DB01): RBP I conducted 10 July 1997

DP01—Dopping Brook, Holliston, MA

HABITAT

Attempts to establish a reference station upstream from existing and proposed groundwater wells in this stream were unsuccessful. Site visits to the headwaters of Dopping Brook found minimal flow and standing pools of water in this portion of the stream. At Brook Street, just downstream from groundwater wells #6 (2136000-06G) and #7 (proposed), current velocity was barely perceptible, making measurements of flow impossible. As a result of these flow contraints macroinvertebrate sampling was qualitative only, resulting in a cursory census of the resident biota. In addition, an evaluation of habitat accompanied the benthos sampling. The habitat assessment, not surprisingly, resulted in an overall low score of 86 out of 200 (Table C1). The lack of productive instream habitat, and poorly developed flow regimes contributed most to the low assessment score. Other habitat parameters, most notably riparian zone development and bank stability, scored well (Table C1).

BENTHOS

Given the very limited productive habitat available at DB01, the macroinvertebrate assemblage was surprisingly diverse, with a variety of trophic guilds represented (Table A3). Of particular interest was the occurrence of pollution-sensitive taxa—most notably Lepidostomatidae and Rhyacophilidae, both of which exhibit low tolerance values of 1 and 0, respectively. Some of the fauna observed at DP01 may in fact be representative of intermittent stream conditions, as several of the taxa present (e.g., Limnephilidae, Lepidostomatidae, Gammaridae, Megaloptera, Rhyacophilidae) have been documented in the literature as occurring in temporary streams (for a review see Hynes 1970).

The effects of the existing groundwater withdrawal upstream from Brook Street are unknown, as are the potential impacts of the proposed second groundwater well. Nevertheless, every effort should be made to preserve the current base flows in this stream, as they support a viable and diverse macroinverebrate community.

Jar Brook (JB01): RBP I conducted 10 July 1997

JB01—Jar Brook, Holliston, MA

HABITAT

The severely degraded riparian and instream habitat quality in Jar Brook downstream from the public groundwater well (2136000-02G) precluded valid benthos comparisons to an upstream control station or the regional reference station (ST01). Nevertheless, a qualitative bioassessment was conducted in attempt to discern the effects of gross impairment to the resident biota. The collection procedure consisted of numerous "jabs" in the dense aquatic vegetation (*Callitriche* sp., *Lemna* sp.), as well as "kicks" in the limited hard substrates (snags, gravel) available immediately upstream from Travis Road. This heavily developed portion (housing subdivisions) of Jar Brook historically has been channelized, and the riparian zone on both sides of the stream has been disturbed. NPS inputs in the form of trash, grass clippings, and other yard waste were observed along much of the stream, especially along the left (east) bank where the vegetative buffer (*Impatiens capensis*, *Myosotis* sp., *Acer* sp.) to encroaching yards is minimal. In addition, severe sand deposition was evident throughout the sampling reach, presumably the result of runoff from adjacent yards and upstream road crossings. JB01 received a habitat assessment score of 74, which represented one of the poorest habitat evaluations in the entire 1997 biomonitoring survey (Table C1).

BENTHOS

Macroinvertebrate sampling resulted in the collection of 12 taxa, many of which display fairly high tolerance values (Table A3). The presence of mostly tolerant taxa suggests the possible effects of organic enrichment in this portion of Jar Brook. Organic and/or nutrient loadings may also contribute to the dense aquatic vegetative growth observed throughout the JB01 sampling reach. Septic system leachate, and other forms of NPS pollution (especially yard wastes—which may contribute elevated levels of instream BOD) are potential sources of enrichment, which may be exacerbated by reduced base flows in this portion of the stream (much of Jar Brook ran dry during the dry summer of 1995) (Bouck, personal communication). It is presently unknown whether low flows at JB01 are naturally occurring or the result of groundwater withdrawal upstream. However, the ongoing sewering of this area may lead to improvements in water quality at the expense of continued habitat quality degradation resulting from further reductions of base flow, which may further impact biological integrity in Jar Brook.

Water Quality Impacts/Point Source Pollution

Charles River (Reach 1, Reach 2, Reach 3): Hester-Dendy artificial substrate samplers deployed 17 August 1997; retrieved 24 September 1997. Sampling conducted by ENSR according to the procedures described in the QAPP (ENSR 1992). Macroinvertebrate community data analyses conducted by DWM.

Reach 1—Charles River, Milford, MA

HABITAT

Multiplate samplers were deployed just downstream from Howard Street in Milford, and are representative of the segment of the river from Howard Street to the Milford WWTP discharge point. ENSR conducted habitat evaluations at four sites within Reach 1, which served as the upstream reference station (i.e., upstream control) for three stations downstream from the WWTP. A detailed description of all Reach 1 habitat evaluations can be found in Charles River Monitoring Program, 1997-Data report No. 8 (ENSR 1998). Habitat quality in this segment of the Charles River was limited with respect to flow regimes and instream substrates conducive to macroinvertebrate colonization. Little to no velocity was observed

upstream of the Milford WWTP discharge during the habitat assessments conducted 9 August 1997. Flow measurements found this portion of the river to discharge at a rate of < 0.10 cfs. Reach 1 received an average habitat assessment score of 55 out of a possible score of 135.

Benthos data collected in Reach 1 by ENSR (1998) revealed a moderately impacted benthic community. Although used as the reference condition to evaluate instream effects in the Charles River associated with the Milford WWTP/Milford Power Limited Partnership facilities, the benthic community was dominated by organisms tolerant of organic pollution and associated low dissolved oxygen concentrations.

The fish assemblage in the Charles River upstream of the Milford WWTP discharge included eight species, three of which were represented by only one individual (ENSR 1998). Many of the species present are typical of warm water, slow moving stream/pond assemblages. The sample was dominated by the pumpkinseed *Lepomis gibbosus*.

Reach 2 and Reach 3—Charles River, Milford/Hopedale, MA

HABITAT

Reach 2 samplers were deployed downstream from South Howard Street at the Milford /Hopedale border, and are representative of the segment between the WWTP discharge and the Mellon Street crossing. Reach 3 samplers were suspended downstream from Mellen Street, at the Milford/Hopedale border, and are representative of the mainstem community between Mellen Street and the Conrail Railroad crossing. Habitat evaluations were conducted at three sites in Reach 2 and four sites in Reach 3, and a complete decription of the assessments can be found in Charles River Monitoring Program, 1997-Data report No. 8 (ENSR 1998). Habitat quality in this segment of the Charles River improved somewhat with respect to the flow regime (a result of the effluent discharge) and substrates suitable for macroinvertebrate colonization (ENSR 1998). However, sedimentation and degraded channel morphology, evidenced by substrate embeddedness and channelization, were prevalent throughout the stream reaches sampled by ENSR. In addition, excessive nuisance aquatic vegetation was observed in the reach just downstream from the WWTP discharge. Elevated nutrients (nitrogen and phosphorus) were in fact documented by ENSR (1998), apparently originating from both the WWTP as well as upstream sources in Milford where failing infrastructure historically has contributed to water quality degradation. Habitat assessments averaged 71 and 68 in Reach 2 and Reach 3, respectively.

BENTHOS

Macroinvertebrate data collected in Reach 2 and Reach 3 (downstream of the Milford WWTP discharge) by ENSR (1998) revealed no impacts as compared to the reference station (Reach 1) community. The only biological attribute of the Reach 2 assemblage found to be significantly different from upstream reference conditions was the community similarity index (Tables B5), which may be a result of less comparable flow regimes. However, the benthic community found at Reach 2, while similar to the upstream reference condition in terms of structure and balance, continues to show signs of moderate impairment. These impacts likely result from organic enrichment and low dissolved oxygen levels. Indeed, dissolved oxygen measurements (ENSR 1998) were occasionally below the Class B Warm Water Fishery standard (< 60% saturation) during the summer months of 1997. However, biological integrity seems to show signs of gradual recovery further downstream, as evidenced by the reappearance of more pollution-sensitive EPT taxa, lower community dominance by one taxon, and increased community diversity in the Reach 3 macroinvertebrate assemblage. In fact, significant differences (based on Student's t-tests) between Reach 3 and Reach 1 for these metrics are the result of improved metric values downstream (Table B6).

The fish assemblage in the Charles River downstream of the Milford WWTP continues to be dominated by warm water, slow moving stream/pond taxa (ENSR 1998). Diversity immediately downstream of the discharge was considerably less than that of the upstream control, with redfin pickerel (*Esox americanus*) and chain pickerel (*Esox niger*) the numerically dominant species. Taxa richness increased to eight further downstream of the discharge, where an assemblage dominated by pumpkinseed (*Lepomis gibbosus*) appeared more similar to the upstream control station.

While impacts originating from the Milford WWTP/Milford Power Limited Partnership facilities were not detected from biomonitoring efforts, resident aquatic communities in this portion of the Charles River continue to reveal the effects of overall habitat and water quality degradation. Organic enrichment, nutrient loading, and sedimentation—probably orginating from illicit sewer connections, stormwater, and failing infrastructure associated with downtown Milford—are the major threats to biological intergrity in this portion of the Charles River. Biological monitoring is recommended in the upper reaches (upstream of downtown Milford, where the Charles River is culverted underground) of the watershed to establish appropriate reference conditions for future biomonitoring studies in this segment of the Charles River. Habitat evaluations and physico-chemical monitoring should accompany future biomonitoring efforts in this segment.

Charles River (CR03 and CR04): RBP III-kick sampling conducted 9 July 1997.

CR03—Charles River, Medway, MA

HABITAT

Macroinvertebrate biomonitoring was conducted in this segment on 9 July 1997 by DWM. The CR03 macroinvertebrate sampling reach began approximately 200 m downstream from Walker Street in Medway. Habitat assessment in this portion of the river found instream substrates and flow regimes to offer excellent habitat for macroinvertebrates, with an abundance of rocky substrates subjected to varying velocity/depth combinations. Instream aquatic vegetation covered approximately 30% of the stream bottom, with the rooted submergent pondweed (*Potamogeton* sp.) the dominant taxon. Both stream banks were well vegetated and stable, although small patches of Japanese knotweed (*Polygonum cuspidatum*) along the left (north) bank suggest past disturbances. A relatively undisturbed riparian zone comprised of shrubs (*Cornus* sp., *Vitis riparia*), trees (*Acer rubrum*, *Ulmus rubra*), and herbaceous forms (*Polygonum cuspidatum*) predominated on the right (south) bank, while commercial development encroached somewhat along the left (north) bank. Nevertheless, nonpoint source pollution inputs from both banks seemed minimal, and the road crossing just upstream from the sample reach showed little indication of gross nonpoint source impacts to the downstream aquatic community. CR03 received a habitat assessment score of 149 out of a possible 200 (Table C1). This station was designated an upstream reference station for CR04, which was established further downstream and downgradient of the CRPCD's regional wastewater treatment facility in Medway. In addition to bracketing the discharge effects of the CRPCD discharge, CR03 was used as a reference station for the CR00 biomonitoring station in the lower Charles River basin. The designation as reference station at CR03 was based on the habitat evaluation conducted there, surrounding land use, and overall water quality relative to other segments of the mainstem Charles River.

BENTHOS

Because CR03 is a reference station, the biological attributes of the macroinvertebrate assemblage sampled there do not yield a final impairment score for the resident aquatic community. However, the metric values calculated as part of the RBP III analysis reflect a healthy benthic community one would expect to find in a "least impacted" stream (Table B9). In particular, those parameters that measure components of community structure (taxa richness, biotic index, and EPT index)—which display the lowest inherent variability among the RBP metrics used—scored well and corroborate the designation as a reference station. CR03 received a total metric score of 40.

CR04—Charles River, Millis, MA

HABITAT

Macroinvertebrate biomonitoring was conducted in this segment on 9 July 1997 by DWM. Sampling was conducted in the Charles River immediately downstream from Dean Street in Millis and downgradient of the Charles River Pollution Control District's regional wastewater treatment facility in Medway. Habitat parameters were highly comparable to the upstream control at Walker Street. Excellent substrates and cover for fish and invertebrates, coupled with a minimally disturbed shrub (*Cornus* sp., *Sambucus canadensis*, *Vitis riparia*) and red maple (*Acer rubrum*)-dominated riparian zone, resulted in a habitat assessment score (160) that was actually better than at the reference station, CR03 (Table C1).

BENTHOS

Results of the RBP III assessment indicate moderate impairment to the benthic community relative to upstream reference conditions (CR03). A total metric score of 14 out of a possible 42 was only 35% comparable to metric scores at CR03 (Table B9). The strong comparability to the reference station in terms of habitat type and quality, coupled with similar stream flow conditions, allowed for a direct comparison of biological condition between upstream and downstream stations. That habitat quality is similar at both sites implies that detected impacts at CR04 can be attributed to water quality factors. The rich filter-feeding macroinvertebrate assemblage found here appears to reflect the effects of considerable organic enrichment, and is indicative of an unbalanced community responding to an overabundance of a food resource (in this case, fine particulate organic material, or FPOM). The presence of Populatic Pond, which is a eutrophic waterbody (BSC 1988), just upstream of the CR04 sample reach is probably at least partially responsible for the high densities of FPOM at CR04. Analysis of the CR04 periphyton community found typically planktonic algae (*Oscillatoria* sp., *Aphanizomenon* sp., *Pediastrum* sp.) as well as other green algae (*Scenedesmus* sp., *Sphaerocystis* sp., *Clostridium* sp.)—many of which were thought to have originated from the upstream impoundment, and are generally indicative of phosphorus enrichment (Beskenis, MA DEP DWM, personal communication). Lentic systems can be a major source of dissolved and suspended particulate organic matter for downstream lotic communities, particularly when these systems are subjected to increasingly enriched conditions (Merritt *et al.* 1984). However, the dominance of filter-feeding organisms in a habitat that should support a diverse benthic community, and almost 100% cover of instream substrates by aquatic vegetation (including filamentous algae and "sewage fungus", *Myriophyllum* sp., *Elodea* sp., *Lemna* sp.) suggests the effects of nutrient loads and excessive organic enrichment one might associate with a wastewater discharge. In addition, the somewhat low taxa richness (19), absence of pollution-sensitive EPT taxa, and high biotic index (6.54) indicate potential low levels of dissolved oxygen (Table B9)—also possibly associated with the CRPCD discharge. Continuous dissolved oxygen meaurements recorded by EPA (1998) just upstream from CR04 in August 1997 found DO levels as low as 5.75 mg/l—just above the minimum DO required to fully support aquatic life in a Class B river. However, observed supersaturated conditions and widely fluctuating DO levels, presumably the result of nutrient-induced plant growth and/or changes in oxygen demanding loadings, may threaten the River's ability to support aquatic life in this portion of the Charles River.

Effects on the Charles River's assimilative capacity, due to flow reductions originating from groundwater withdrawals in the Populatic Pond /Charles River aquifer, are unknown. Several groundwater withdrawals (2177000-01G, 2177000-03G, 4101000-08G) currently exist near the juncture of Medway/Franklin/Norfolk, and Populatic Pond Well #11 has been proposed just upstream of Populatic Pond. However, flow measurements taken concurrent with biomonitoring activities in this portion of the river found considerably greater flow downstream from the existing water withdrawals at CR04 (34.44 cfs) than at CR03 (15.94 cfs). Increases in flow downstream from the groundwater wells are probably the result of discharge contributions from the CRPCD facility.

Charles River (CR05 and CR06): Hester-Dendy artificial substrate samplers deployed 11 July 1997; retrieved 3 September 1997.

CR05 and CR06—Charles River, Medfield, MA

HABITAT

Macroinvertebrate biomonitoring was utilized in an attempt to assess effects of the effluent discharge from the Medfield POTW. Triplicate artificial substrate samplers were deployed by canoe on 11 July 1997 approximately 1000 m upstream from West Street (control site CR05) and approximately 500 m downstream from the POTW discharge (study site CR06). Habitat, flow regimes, and depth were similar at both stations and were typical of this portion of the Charles River. The deep, soft-bottomed, and slowly moving channel meandered through extensive wetlands dominated by purple loosestrife (*Lythrum salicaria*) and occasional shrubs (*Cephalanthus occidentalis*, *Cornus* sp.). In addition, the proliferation of submergent (*Sparganium* sp., *Potamogeton* sp.), emergent (*Pontederia cordata, Polygonum* sp.), and floating aquatic vegetation (*Lemna* sp.) at both the CR05 and CR06 stations indicated the productive nature of this system. Turbidity in the water column was observed at both stations, and was particularly excessive at the downstream station where near-opaque conditions existed. With the exception of the Medfield POTW and some light residential development, adjacent land use in this portion of the Charles River is mostly open space. CR05 received a habitat assessment score of 113 out of 200, while the CR06 habitat evaluation resulted in a score of 131.

BENTHOS

After a colonization period of seven weeks, the artificial substrate multiplate samplers were retrieved and triplicate samplers were processed separately in the lab. The unfortunate loss of two of the three multiplate samplers at the CR05 station precluded the use of statistical hypotheses testing for evaluating discharge impacts to the downstream aquatic community. Instead, the analysis of upstream and downstream macroinvertebrate assemblages was based on the multimetric scoring approach of the RBP III protocol, in which comparability of metric scores to the reference condition is used to generate an impairment score for the study site. For six of the seven biological metrics calculated, CR06 actually scored higher (based on the mean metric values of triplicates) than the reference station (Table B7). For the community similarity metric, macroinvertebrate assemblages on CR06 multiplates were considered similar to the assemblage found at CR05 based on an average coefficient of community index (cc index) of 0.60 (Table B7). Based on the multimetric comparisons, then, it appears that the CR06 benthic community is not impacted by the Medfield POTW, and is similar to—if not better in terms of biological integrity—the upstream reference community. However, it is important to exercise caution when interpreting the benthos data at CR05 and CR06. It is possible that the disturbance that led to the loss of the two multiplate samplers at CR05 may have affected the remaining sampler as well. Heavy fishing pressure and canoe traffic in this portion of the river may account for the disruption of some or all of the multiplate samplers, which were suspended from fairly conspicuous buoys. Multiplate samplers at the CR05 station may have been particularly susceptible to fouling, vandalism, or other perturbations, as they were placed well into the middle of the channel. A final caveat regarding the benthos data at the CR05/CR06 stations is the seemingly dubious "reference" designation of the CR05 station. Half of the organisms found on the CR05 multiplate were either *Glyptotendipes* sp. or *Endochironomus* sp.—midges highly tolerant of organic pollution (Table A1). The majority of the remaining taxa were also in the Chironomidae family and are considered pollution-tolerant.

It is possible that the cumulative effects of wastewater treatment facilities further upstream (i.e., CRPCD; point sources in the Stop River—see below) are exhibited at the CR05 and CR06 sites as well. Indeed, water quality monitoring data collected in this portion of the river suggests that reduced dissolved oxygen levels and elevated nutrient levels may compromise biological integrity. Although DO did not drop below 5.0 mg/l, saturation did fall below 60% at the downstream sampling locations where continuous DO measurements were made (CDM 1997). Chlorophyll *a* concentration, a measure of primary productivity, was also elevated and indicative of enriched conditions (CRWA 1997; CDM 1997). In addition, a large sand and gravel operation just upstream in the vicinity of Route 109 may be another source of anthropogenic impact to the biological integrity of this river segment. Future bioassessments in this portion of the river should include comparisons to a suitable reference station established further upstream near the headwaters or a regional reference site.

Stop River (SR01, SR02, and SR03): RBP III-kick sampling conducted 8 July 1997.

SR01—Stop River, Norfolk, MA

HABITAT

Benthic macroinvertebrate biomonitoring was conducted at SR01 and SR02 to bracket the combined effects of the Wrentham State School and Southwood Community Hospital wastewater discharges. The upstream reference station, SR01, was established near the headwaters of the Stop River, approximately 100 m downstream from Pine Street in Norfolk. The dense hardwood forest in this portion of the watershed provided the stream with an undisturbed and wooded *(Acer rubrum*, *Alnus* sp., *Ulmus rubra*) riparian zone with a profusion of wetland vegetation (*Symplocarpus foetidus*, *Typha latifolia*) throughout its understory. Instream habitat quality was also considered excellent, with well-developed riffles and a variety of hard substrates (e.g., cobble, gravel, snags and submerged wood). Aquatic vegetation in the sampling reach, while minimal, was dominated by rooted emergent forms (*Nasturtium* sp., *Polygonum* sp.). NPS inputs to the sampling reach appeared to be minimal, however, observed instream deposits of sand probably originated from the Pine Street crossing and/or a sand and gravel operation just upstream from Pine Street. SR01 received a total habitat assessment score of 159 out of 200 (Table C1). The absence of upstream point source discharges, minimal nonpoint source inputs, an undisturbed riparian zone, and diverse instream substrates and flow regimes corroborate its designation as a reference station for this sub-basin.

BENTHOS

The benthic community sampled at SR01 consisted of a fairly diverse assemblage of pollution-sensitive taxa. Dominant taxa comprised only 13% of the sample, indicative of a well-balanced community. The SR01 benthos data were also compared to the regional reference station community (ST01) established at Stony Brook in Weston. A total metric score of 24 was 60% comparable to regional reference conditions (Table B8). Differences in community structure and function can probably be attributed to natural differences between the two sub-watersheds, particularly in terms of the food resources available. The naturally unproductive conditions at the SR01 station probably preclude the presence of filter-feeding taxa such as the Hydropsychidae, which are numerous at the ST01 station (Table A2).

SR02—Stop River, Norfolk, MA

HABITAT

The SR02 sampling reach was immediately downstream from Campbell Street in Norfolk, and downgradient from Highland Lake. Instream habitat here was considered excellent for macroinvertebrates, with an abundance of rocky substrates subjected to a variety of velocity/depth combinations. Deep pools, snags, and submerged logs provided fish with excellent cover as well. The stream was well buffered from NPS inputs, with a wide undisturbed riparian zone of hardwood trees (*Acer rubrum*, *Quercus rubra*, *Ulmus rubra*), conifers (*Pinus strobus*), and shrubs (*Cornus* sp., *Vitis riparia*) extending from stable banks along both sides of the channel. With the exception of mosses, instream vegetation was minimal, probably due to the shaded canopy cover. SR02 received a habitat assessment score of 177 out of 200—one of the highest evaluations encountered in the Charles River watershed.

BENTHOS

While the diverse and undisturbed instream habitat should have supported an equally diverse aquatic community, the SR02 benthos received a total metric score of only 16. The low percent comparability (38%) to upstream reference station metrics resulted in a moderate impairment designation (Table B8). When compared to the regional reference station ST01, the total metric score at SR02 was only eight—20% comparable to reference conditions and resulting in moderate/severe impairment of the benthic community (Table B8). Regardless of which reference station is used, it is apparent that the aquatic community at SR02 is not reflective of "best-attainable conditions" for this portion of the watershed. The dominance of the community by relatively few taxa, particularly the filter-feeding finger nail clam (Pisidiidae) indicates an

unbalanced community responding to an overabundance of fine particulate organic matter in the water column.

That the assemblage is dominated by filter-feeders is not surprising, as Highland Lake is no doubt a contributing source of suspended FPOM; however, the sheer numbers represented by these taxa are somewhat disconcerting and indicative of effects from excessive upstream enrichment. Typically, in lentic systems such as the impoundment upstream, the primary source of organic matter is autochthonous (produced within the system), with secondary inputs of allochthonous (transported into the system from someplace else) materials from shoreline vegetation and fluvial inputs (Wetzel 1975, Merritt et al. 1984). Phytoplankton production—and to a lesser extent, littoral vascular plant production—and associated dissolved organic matter (DOM), are the primary source of autochthonous matter (Wetzel 1975). It is the physical-chemical flocculation (nonbiological) of this DOM and/or other biological processes that leads to the formation of FPOM, the primary nutrition resource utilized by filter-feeders (Wetzel 1975). While FPOM production in lotic systems is primarily a result of the processing of microbially colonized Course Particulate Organic Material (CPOM) contributed by aquatic shredders, the high concentration of FPOM in stream systems immediately below pond and reservoir outlets has mainly lentic origins. If these lentic systems are subjected to increasingly eutrophic conditions the resulting effects of enrichment (i.e., increased algal, plant, and DOM production) can be seen not only in the lentic fauna, but also the lotic aquatic communities immediately downstream.

The dense filter-feeding pisidiid assemblage at SR02 appears to reflect the effects of considerable upstream enrichment, and is indicative of a community responding to an overabundance of a food source. In addition, the low taxa diversity (10), reduction of EPT taxa (3), and high biotic index (5.61) relative to reference conditions indicate potentially low levels of dissolved oxygen—possibly a result of increased biological oxygen demand in Highland Pond. While there is an unfortunate lack of diurnal dissolved oxygen data for this portion of the river, DO data collected by CDM as part of their wasteload allocation study (1997) found post-dawn levels as low as 3.8 mg/l further downstream.

SR03—*Stop River, Norfolk, MA*

HABITAT

Macroinvertebrate biomonitoring downstream from the MCI discharge was conducted at Noon Hill Avenue in Norfolk. This low-gradient portion of the Stop River meandered through extensive and undisturbed wetlands before joining the Charles River at the Medfield/Millis border. Instream habitat was considerably more limited here than at the two upstream Stop River stations. Shifting soft substrates, covered with a profusion of rooted emergent vegetation (*Typha* sp., *Pontederia cordata*, *Sparganium* sp.), dominated the stream bottom. Dense beds of *Callitriche* sp. and filamentous algae were also common. The lack of hard substrates, moderate sediment deposition, and poorly established flow regimes resulted in a habitat assessment score of only 129 out of 200. In addition to sediment loading, the abundance of instream trash was a form of NPS pollution in the sampling reach. These NPS inputs, while potentially impacting the resident biota of the sample reach, appeared to be localized only (probably a result of road runoff from Noon Hill Avenue) and not representative of the entire segment.

BENTHOS

The benthos data suggested an unbalanced macroinvertebrate community, with the filter-feeding Hydropsychidae comprising the majority of the assemblage sampled. SR03 received a total metric score of 16, representing 38% comparability to the headwater control station at Pine Street (SR01) and indicating moderate impairment to the aquatic community (Table B8). When comparing the SR03 community to the regional reference station ST01, a total metric score of 12 again indicated moderate impairment (Table B8). Contributing most to the impairment score were the dominance of the assemblage by one taxon, low community similarity to the reference assemblages, and low densities of pollution-sensitive EPT taxa. While the high densities of filter-feeding caddisfly larvae suggest an overabundance of one food resource due to organic enrichment (Although the extensive wetland margins upstream of SR03 may offer substantial organic inputs in the form of allochthonous materials. Through a variety of abiotic and biotic processes these materials become available as high quality FPOM for filter-feeders such as Hydropsychidae who use silken nets to capture this food resource as it is suspended in the water column.), the lack of non-hydropsychid EPT

taxa may suggest reduced dissolved oxygen levels often associated with organic pollution. In addition, the limited microhabitat suitable for macroinvertebrate colonization—due to sedimentation and the absence of hard substrates—may contribute to low taxa diversity and EPT richness. Unstable and sandy substrates may also be responsible for the preclusion of filamentous algae at SR03, as qualitative periphyton assessments found the erect diatom *Melosira* sp. to dominate this community (Table C3).

To most effectively assess the impacts of the MCI discharge on the downstream aquatic community at SR03, comparisons were made to the SR02 station located upstream from the discharge. Based on this upstream-downstream comparison of biological integrity, SR03 received a total metric score of 26, which was 72% comparable to the SR02 benthos assemblage (Table B8). As this resulted in an assessment of biological integrity of only slightly impaired for the SR03 macroinvertebrate community, it can be concluded that the MCI discharge does not noticeably contribute to degradation of the downstream community. In fact, many of the biological metrics calculated for the SR03 assemblage—most notably, taxa richness, biotic index, EPT index—scored as well as, or better, than those calculated for the SR02 benthos.

Organic enrichment, resulting from the combined effects of all upstream point source inputs to the Stop River, probably accounts for most of the water quality degradation reflected in the resident aquatic community at SR03. Reduced dissolved oxygen levels may sporadically exist throughout the segment (either a function of the low-gradient wetland stream system and/or organically enriched conditions), as DO data collected by CDM as part of their wasteload allocation study (1997) found post-dawn DO levels as low as 3.8 mg/l near the confluence with the Charles River.

The Norfolk MCI facility has conducted whole effluent acute and chronic toxicity testing on a quarterly basis since April 1991. Fourteen test events have occurred since March 1994 (in the last five years). While the effluent has consistently met the acute toxicity limit, sporadic chronic toxicity to both *Ceriodaphnia dubia* and *Pimpephales promelas* has been detected; thus, posing a threat to the receiving stream. However, the abundance of Hydropsychidae at SR03 probably precludes the presence of toxicants in this portion of the Stop River, as filtering collectors are sensitive to toxicants bound to the fine particles on which they feed on (Cummins 1987).

Water Quality and Habitat Impacts/Nonpoint Source Pollution

Charles River (CR00): RBP III-kick sampling conducted 15 July 1997.

CR00—Charles River, Watertown, MA

HABITAT

DWM conducted macroinvertebrate biomonitoring in a wadeable reach immediately downstream from the Watertown Dam, which delineates the most upstream extent of the spring herring (*Alosa* sp.) run in the Charles River. An abundance of rocky substrates and varying flow regimes provided excellent instream benthic habitat. In fact, epifaunal substrates here were rated as high as any of the biomonitoring stations in the 1997 survey. However, a degraded and disturbed riparian zone throughout the reach led to a poor overall habitat evaluation and an assessment score of only 116 out of 200 (Table C1). NPS inputs, primarily trash and yard waste (i.e., grass clippings and leaves), were observed along the left (north) bank where much of the riparian zone was removed. Serious erosion was evident along much of the right (south) bank, where the vegetative buffer (*Acer rubrum*, *Ulmus rubra*, *Salix* sp., *Ramnus* sp., *Cornus* sp.) was also quite minimal. Also of note were the strong petroleum odors arising from instream sediments throughout the sampling reach. Several minor NPDES permittees discharge stormwater into the river just upstream from CR00, including Mobil Oil Corporation (discharges to Charles River and Cheese Cake Brook).

BENTHOS

The macroinvertebrate community received a total metric score of 16, which was 40% comparable to the designated upstream reference station CR03 in Medway. The dominance of filter-feeders and pollution-tolerant forms, and lack of EPT taxa indicate this community is structured in response to organic enrichment and associated elevated levels of FPOM. Indeed, heavy deposits of particulate matter were observed on

instream substrates, and a thriving algal community throughout the sampling reach reflected the effects of enrichment. Periphyton community analyses identified most algae present as filamentous forms of *Spirogyra* sp. and *Rhizoclonium* sp., considered nuisance aquatic growth since high abundance can smother substrates and eliminate the habitat for more desirable species of algae which are better food sources for fish and invertebrates (Biggs and Price 1987). The absence of scrapers, as evidenced in the low scraper/filterer metric value (Table B9) further suggests that the periphyton-feeding community at CR00 has been displaced by an unbalanced community responding to an overabundance of FPOM. These scraper-feeding organisms, which graze on diatoms associated with a healthy periphyton food base, cannot effectively harvest the filamentous algae that thrives in organically enriched systems (Plafkin et al. 1989). Dissolved oxygen levels, while not representing worst-case conditions, appeared normal at CR00. However, the elevated levels of phosphorus (MA DEP 1998a) at the DWM sampling station coupled with the high chlorophyll *a* concentrations (as high as 48 µg/l at Massachusetts Avenue) measured by CRWA (1998) further downstream corroborate the eutrophic nature of this segment.

Impairment to the CR00 macroinvertebrate community appears to be primarily the result of degraded and organically-enriched water quality originating from stormwater inputs, illicit sewer discharges, and other forms of runoff associated with this heavily urbanized portion of the watershed. Elevated fecal coliform bacteria counts documented by CRWA (1998) at their seven monitoring stations in this segment of the Charles River (range from < 10 – 16,900 cfu/100 ml during baseline conditions and < 10 – 59,000 cfu/100 ml during wet weather conditions in samples collected between October 1995 and December 1997) further support the assessment that urban runoff is a major threat to water quality in the lower Charles River basin. Although instream habitat—particularly substrates and flow regimes—are not representative of the entire segment, macroinvertebrate samples collected (using artificial substrate samplers) as part of the Supplemental Phase 2 Remedial Investigation Report and Aquatic Ecological Assessment Report (Plexus 1996) reveal a severely degraded benthos community in this portion of the river. Low diversity, and the dominance of extremely pollution-tolerant taxa—most notably, tubificid worms—were consistently observed in the vicinity of the Watertown Arsenal, where soft substrates and low instream velocities are typical of this portion of the watershed and corroborate the bioassessment conducted further upstream at CR00.

Stony Brook (ST01): RBP III-kick sampling conducted 15 July 1997

ST01—Stony Brook, Weston, MA

HABITAT

Macroinvertebrate and fish biomonitoring were conducted approximately 50 m downstream from Church Street. The sampling reach was actually composed of two channels formed from the divergence of Stony Brook just upstream from Church Street. The channels run parallel to each other for approximately 55 m before merging together near the bottom of the sampling reach. Sampling was necessary in both channels to allow for the ten "kicks" in 100 m of productive habitat, as specified in the sampling protocol. Both channels of the ST01 sampling reach provided macroinvertebrates with clear, cold water in a variety of flow regimes. Cobble-dominated substrates and a variety of woody debris created excellent epifaunal habitat for macroinvertebrates and ample cover for fish. Some sediment deposits were observed (probably the result of runoff from Church Street), but they were confined to pool areas rather than embedding the hard substrates in the riffle zones. Instream algal cover was minimal, while rooted emergents (*Glyceria* sp., *Peltandra* sp., *Myosotis* sp.)—though not abundant—were the dominant form of aquativc vegetation. Stream banks along both channels were stable and well vegetated, and a forested riparian zone with a diverse assemblage of trees (*Acer* sp., *Fraxinus* sp.), shrubs (*Ramnus* sp., *Lindera* sp.) and herbaceous growth (*Bohmeria* sp., *Lythrum* sp., *Myosotis* sp.) extended undisturbed in both directions. The ST01 sampling reach received a habitat assessment score of 155. ST01 was designated a regional reference station for the Charles River watershed biomonitoring survey by virtue of its high habitat evaluation, minimal upstream/adjacent land use impacts (e.g., absence of point source inputs, lack of channelization, minimal development and agricultural activity nearby, undisturbed and well vegetated riparian zone), and excellent water quality (as determined from previously conducted monthly water quality sampling).

BENTHOS

Benthos data revealed an assemblage indicative of the "best attainable conditions" in the watershed. The macroinvertebrate community was characterized by a diverse and well-balanced assemblage of pollution-sensitive taxa, and was especially rich in clean water forms of EPT taxa (Table B10). In fact, the taxa richness (30) and EPT index (12) observed at ST01 were as high as any biomonitoring station sampled by DEP in the Commonwealth during1997! In addition, this was the only biomonitoring station in the Charles River watershed represented by more than one species of Plecoptera—generally considered the most pollution-sensitive insect order. And while the dominant taxon in the ST01 macroinvertebrate assemblage (*Dolophilodes* sp.) comprised 25% of the sample, this species displays virtually no tolerance of organic pollution (Table A2).

Fish community sampling yielded three taxa (Table C2), eastern brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), and redfin pickerel (*Esox americanus americanus*)—all pollution-intolerant forms. All brook trout caught were young-of-the-year individuals, and while the Division of Fisheries and Wildlife (DFW) stocks this stream annually with brown trout, individuals collected at ST01 appeared to be native (Maietta, MA DEP DWM, personal communication).

Waban Brook (WB01): RBP I-kick sampling conducted 21 August1997

WB01—Waban Brook, Wellesley, MA

HABITAT

Macroinvertebrate biomonitoring and habitat evaluation were conducted at WB01 to establish baseline biological conditions in this stream and to assess NPS impacts—if any—to this portion of Waban Brook. The WB01 sampling reach was just downstream from DWM's water quality monitoring station, at an unnamed dirt road just off Service Road in Wellesley. Here the stream meandered through an area of dense shrub (*Vitis riparia*, *Cornus* sp., *Rhus radicans*) and herbaceous (*Impatiens capensis*) growth, with an occasional hardwood tree present. Instream substrates offered good habitat for macroinvertebrates, with an abundance of cobble and gravel subjected to shallow riffles. Both stream banks and riparian zones were generally stable and well vegetated; however, a small portion of the left (east) bank offered only a minimal buffer against potential NPS inputs from an adjacent lawn. In addition, the dirt road crossing at the top of the reach may be responsible for observed instream deposition. Although instream substrates and riparian habitat in this portion of the stream were good, low flows precluded the use of RBP III sampling. WB01 received a habitat assessment of 151 out of 200 (Table C1).

BENTHOS

Qualitative macroinvertebrate screening found trophic structure to be dominated by filter-feeders; not surprising considering the proximity of the sampling station to Lake Waban and Morse Pond. High water temperature (21.3°C) during the sampling period may explain the absence of non-Trichopteran EPT taxa, as the lethal limits for some species of Plecoptera and Ephemeroptera are around 20°C (Wiederholm 1984). An abundance of elmid beetles indicated the presence of additional food resources (i.e., periphyton) as well as suitable levels of dissolved oxygen for this taxon's respiratory requirements. Overall, NPS impacts to this portion of Waban Brook seem minimal, and the resident biota appears to reflect the generally good water quality documented by DWM's physico-chemical monitoring efforts at this location (MA DEP 1998a).

Fuller Brook (FB02): RBP III-kick sampling conducted 21 August 1997

FB02—Fuller Brook, Wellesley, MA

HABITAT

Macroinvertebrate biomonitoring was conducted upstream from DWM's FB01 water quality station in a reach more appropriate for the RBP "kick" sampling methodology. The sampling reach extended from Cameron Street near downtown Wellesley, to an unnamed tributary's confluence with Fuller Brook. Habitat in this

portion of Fuller Brook was good, considering the urban nature of this sub-watershed. Instream habitat and flow regimes were conducive to macroinvertebrate colonization, with an abundance of rocky substrates and riffle areas. Occasional pools with woody debris provided adequate depth and cover for observed populations of small fish. The riparian zone, while extremely narrow, provided at least some buffer (ferns, *Polygonum cuspidatum*, *Vitis riparia*, *Rosa* sp.) from anthropogenic activity adjacent to the stream (walking paths and school playgrounds extend along most of the reach). Red maple (*Acer rubrum*) and white pine (*Pinus strobus*) dominated the forested portion of the riparian zone along the left (south) bank, although a walking path exists here as well. FB02 received a habitat assessment of 138 out of 200 (Table C1). The reduced riparian vegetative zone width, and moderate deposits of FPOM causing substrate embeddedness, contributed most to habitat degradation in the sampling reach.

BENTHOS

The benthos data revealed the effects of an excessively enriched system. Virtually all taxa in the assemblage collected were filter-feeders, most in the family Hydropsychidae (Table A2). Taxa richness, biotic index, and EPT index metrics also scored poorly relative to the reference condition at STO1 (Table B10). FB02 received a total metric score of 12, which was only 30% comparable to the regional reference station and resulted in a bioassessment of moderately impaired (Table B10). The FB02 aquatic community appears to be structured in response to an overabundance of FPOM and the effects of water quality degradation, rather than to the diverse instream microhabitat available. The presence of the filamentous algae *Spirogyra* sp., and *Melosira* sp. corroborates the effects of enrichment in this portion of the stream (Table C3). As these algal taxa are considered to be grazer resistent (Biggs and Gerbeaux 1996), their presence probably contributes to the low scoring scraper/filterer metric at FB02 (Table B10). A permanent and thriving waterfowl population upstream from the sample reach is the likeliest source of organic inputs to this portion of Fuller Brook. Indeed, fecal coliform data collected at FB01 ranged between 40 and 4,000 cfu/100 ml on ten dates between July 1997 and April 1998 (MA DEP 1998a; CRWA 1997). Additional DWM sampling bracketed the unnamed tributary, which drains a small impoundment opposite the Wellesley town hall. This impoundment is populated with a large duck population and is a popular "feeding" area. Fecal coliform counts upstream of this tributary did not exceed 200 cfu/100 ml whereas counts of 1,600 cfu/100 ml were documented downstream of the tributary confluence with Fuller Brook (which marks the top of the FB02 sampling reach) (MA DEP 1998a). Continued feeding of waterfowl in the Wellesly town hall duck pond is strongly discouraged, as associated bacteria and nutrient loadings appear to be severely degrading water quality in its unnamed tributary, Fuller Brook, and possibly further downstream in the mainstem Charles River itself (CRWA (1997) documented elevated bacteria levels in the Charles River at Charles River Road, just downstream from Waban Brook/Fuller Brook).

Trout Brook (TB01): RBP III-kick sampling conducted 16 July 1997

TB01—Trout Brook, Dover, MA

HABITAT

Macroinvertebrate biomonitoring was conducted downstream from Haven Street, Dover, in a beautiful portion of Trout Brook. The sampling reach began approximately 110 m downstream from the road crossing, and extended upstream to a shallow pool near Haven Street. Surrounding land use in this part of the watershed is primarily open space (forest and pasture), light residential, and agricultural. Much of the reach was comprised of cobble and boulder substrates coincident with a variety of shallow and deep riffles. In fact, epifaunal substrates at TB01 were rated the highest of all biomonitoring stations in the watershed (Table C1). Pools with an abundance of stable habitat provided fish with excellent cover, particularly at the downstream end of the reach where pools were quite deep. Bank stability was good through the sampling reach, and a wide riparian zone of shrubs (*Ramnus* sp., *Alnus* sp., and *Cornus* sp.), red maple (*Acer rubrum)*, and herbaceous growth (*Symplocarpus foetidus*, *Onoclea* sp., *Thalictrum* sp.) provided a buffer against adjacent agricultural activities. Upstream from the reach, however, potential NPS inputs may impact this portion of Trout Brook. Road runoff from Haven Street is directed to the stream via paved "swales," and agricultural activities—most notably the piling of manure (observed during the biomonitoring survey and additional water quality surveys) near a poorly buffered portion of the stream—may pose a threat to downstream aquatic communities. TB01 yielded a habitat assessment score of 179—the highest evaluation received by a biomonitoring station in the Charles River watershed during the 1997 survey.

BENTHOS

Despite the excellent habitat available, the benthic community analysis found an assemblage only 30% comparable to reference conditions at ST01 (Table B10). Particularly alarming were the lack of EPT taxa and a dominance of the assemblage by the Chironomidae, which contributed to the result of moderately impaired for benthic community assessment (Table B10). Potential causes of impairment are nutrient enrichment, reduced oxygen levels, and pesticides. Monthly dissolved oxygen measurements taken by DWM during 1997 were all made between 0846 and 1230 and therefore do not represent worse-case conditions; however, saturation was below 60% on one occasion and near 60% during two other sampling events (MA DEP 1998a). Pesticides have been shown to eliminate top level predators such as the Trichoptera and Plecoptera, leading to increased Dipteran densities (Wiederholm 1984). The periphyton community assessment conducted by DWM—which found a paucity of algae at this station—corroborates potential pesticide effects on the biological community in this portion of Trout Brook (Table C3). Another practice associated with agricultural activities that may impact biological integrity at TB01 is the use of fertilizers. The chironomid *Tvetenia bavarica*, the dominant taxon in the TB01 assemblage, has been shown to prefer cool-water streams exhibiting nutrient-enriched conditions (Bode and Novak 1998). The application of fertilizers to adjacent crops, as well as other sources of non-agricultural nutrient loadings, should be investigated in this portion of Trout Brook. Excessive organic enrichment does not appear to be a major cause of benthos impairment, as evidenced in the fairly high scoring biotic index metric and scraper/filterer metric. And while the chironomid *Tvetenia bavarica* gr. dominated the macroinvertebrate sample, this taxon displays only moderate tolerance of organic pollution (Table A2). Nevertheless, future piling of manure near Trout Brook in the vicinity of Haven Street is strongly discouraged.

The instream temperatures in Trout Brook were the coolest measured by DWM in the Charles River watershed. This stream, although not classified as a Cold Water Fishery, does support a native eastern brook trout population. In fact, electroshocking by DWM in the TB01 biomonitoring reach yielded a total of 49 trout (*Salvelinus fontinalis*), including several young-of-the-year (Table C2)! Also collected were 33 redfin pickerel (*Esox americanus americanus*) (Table C2), which, like eastern brook trout, are considered pollution-intolerant

Powissett Brook (PB01): RBP III-kick sampling conducted 16 July 1997

PB01—Powissett Brook, Dover, MA

HABITAT

One of the smallest tributaries in the Charles River watershed, Powissett Brook drains an area of mostly forested and undeveloped space. Macroinvertebrate biomonitoring was conducted on 16 July 1997 in a reach beginning approximately 110 m downstream from Wilsondale Road in Dover. While rocky instream substrates prevailed throughout the sampling reach, inadequate stream depth left (west) much of the microhabitat unavailable for macroinvertebrate colonization. Likewise, an abundance of snags and other woody material normally providing good instream cover for fish was mostly exposed due to the shallow nature of the pools. Channel morphology and riparian habitat were excellent, as the stream meandered through a dense hardwood *(Acer rubrum, Quercus rubra*) forest. Instream vegetation (with the exception of aquatic mosses) was absent, probably due to the closed-canopy nature of the stream reach. NPS inputs in the form of runoff from the Wilsondale Road crossing appeared absent, as reflected in the high habitat scores for the embeddedness and deposition parameters (Table C1). The sampling station received a habitat assessment score of 138 out of 200 (Table C1).

BENTHOS

Although the habitat assessment at PB01 was considered "supporting," those habitat parameters most dependent on flow were somewhat limiting. Flow regime and current velocity are important hydrologic determinants of benthic community ecology. Flow volume and velocity/depth combinations can have effects on substrate composition and stability, the amount of channel under water, and food availability (Minshall 1984). Current plays a crucial role in the distribution of benthic macroinvertebrates—current velocity affects

an organism's ability to gather food, meet respiratory requirements, avoid competition and predation, and colonize or vacate certain habitats (Minshall 1984). Short-term flow fluctuations may modify benthic communities in several ways, most notably by stranding them in pockets of standing water or on exposed substrates. The potential for stranding at PB01 may explain the lack of Ephemeroptera, as mayflies are particularly susceptible to stranding (Ward 1984). Decreasing discharge may induce drift of aquatic organisms; that is, the downstream transport by current of benthic animals as a means of escape or dispersal (Wiley and Kohler 1984; Ward 1984). This taxa depletion, either by drift or the periodic loss of riffle habitat, may contribute to the low taxa richness and EPT index (score=0), and subsequent impairment to the PB01 community. Members of the Chironomidae family, some of which may display low flow adaptations, dominated the macroinvertebrate assemblage at PB01 and contributed to the low community similarity to reference conditions at ST01 (Table B10). And while not included in the macroinvertebrate community analysis, high densities of crayfish (order: Decapoda) were observed throughout the shallow pools of the sampling reach. The highly mobile nature of these invertebrates may make them less susceptible to periods of reduced flow that may threaten other forms of benthic organisms at PB01. Given the extremely reduced flow conditions and the fact that the resident benthic community was dominated by pollution-sensitive taxa (the numerically dominant *Micropsectra* spp. may be highly intolerant of organic pollution depending on the species), it appears that it is flow constraints—not water quality constraints—that shape the structure and function of the instream biota in Powissett Brook. Evidence of good water quality may also be indicated by the dense instream cover of sponges, which are generally considered to be pollution sensitive invertebrates.

Fish sampling, conducted in the shallow and limited pool habitat available in this portion of the stream, yielded only two chain pickerel (*Esox niger*)—probably originating from the upstream impoundment (Table C2). The low percent comparability (45%) to reference conditions at ST01 resulted in a moderately impaired benthos assessment. It is unknown, however, whether biological impairment is the result of naturally occurring low flows or exacerbated by the damming at upstream impoundments. There are no community water supplies (i.e., groundwater or surface water withdrawals) in the Powissett Brook watershed. An investigation into the presence/extent of damming structures in the impoundments of this watershed (especially the headwater impoundments—Powissett and Noannet Ponds), and potential reduced flow effects on downstream aquatic communities, is recommended.

Alder Brook (AB01): RBP III-kick sampling conducted 16 July 1997

AB01—Alder Brook, Needham, MA

HABITAT

Macroinvertebrate and fish sampling was conducted in July 1997, in a reach beginning approximately 100 m downstream from South Street in Needham. Upstream from South Street the stream receives considerable drainage from Needham Reservoir and an unnamed tributary that originates upstream from the reservoir. Heavy to moderate residential and commercial land use are prevalent along much of Alder Brook, while large tracts of recreational space (playground and golf course) comprise the remainder of the drainage area. Despite some residences adjacent to the AB01 sampling reach, a forested riparian zone along both stream banks provided a good vegetative buffer from anthropogenic perturbations. Road runoff in the form of sand deposition, originating from the South Street crossing, has resulted in the development of a "beach" adjacent to the upper extent of the sampling reach. Instream deposition and substrate embeddedness, however, were minimal. Well-developed (albeit shallow) riffle areas, with an abundance of cobble/gravel substrates, provided optimal habitat for macroinvertebrates throughout much of the reach. Instream cover, in the form of snags and woody debris, provided fish with adequate habitat for maintenance of populations. An abundance of overhanging shrubs (*Ramnus* sp., *Cornus* sp., *Alnus* sp.) provided fish with additional cover, particularly at the lower end of the reach. The remainder of the riparian zone was dominated by white ash (*Fraxinus americana*), maple (*Acer* sp.), slippery elm (*Ulmus rubra*), and herbaceous growth (*Impatiens* sp., *Symplocarpus* sp., *Parthenocissus* sp.). Instream vegetation, while minimal, was comprised of various rooted emergent forms (hydrophyllic grasses, *Boehmeria* sp., *Impatiens* sp., *Cicuta* sp.). AB01 received a total habitat assessment score of 159 out of 200 (Table C1).

BENTHOS

Although the habitat evaluation resulted in an assessment score (159) that was higher than that received at the ST01 reference station (155), the benthic macroinvertebrate community was only 45% comparable to reference conditions. Low overall taxa richness and an especially low EPT index contributed to a total metric score of only 18 out of a possible 42 (Table B10), resulting in a determination of moderate impairment to the benthic community. An abundance of filter-feeding Hydropsychidae (48% of the assemblage) suggests somewhat organically enriched conditions and a preponderance of FPOM, possibly originating from the upstream reservoir. Results of fish sampling (Table C2), which revealed a community dominated by warm water taxa (especially pumpkinseed *Lepomis gibbosus*), also suggest that the impoundments upstream may shape community structure and function in this portion of the stream. Results of DWM's water quality monitoring at AB01 found slightly elevated levels of nutrients, with total phosphorus concentrations ranging from 0.02-0.09 mg/l and ammonia-nitrogen as high as 0.14 mg/l on one occasion (MA DEP 1998a). These nutrients, possibly originating from the golf course upstream of Needham Reservoir, the reservoir itself, or other unknown NPS inputs associated with the urbanized nature of this watershed (e.g., stormwater) may contribute to organic enrichment and other forms of water quality degradation, and the resulting effects on the resident biota at AB01. Elevated levels of fecal coliform bacteria (as high as 1280 cfu/100 ml during dry weather) were also documented by DWM at AB01 (MA DEP 1998a), further corroborating that water quality shortcomings (rather than habitat) affect biological integrity in this portion of Alder Brook. Despite the excellent habitat evaluation received by AB01, the implementation of appropriate Best Management Practices (BMP's) is strongly recommended in the vicinity of South Street. Sediment inputs originating from this road crossing pose a serious threat to instream habitat quality and associated biota.

Rock Meadow Brook (RM01): RBP I-kick sampling conducted 16 July 1997

RM01—Rock Meadow Brook, Westwood, MA

HABITAT

Biological sampling in this stream was expected to complement DWM water quality data, and investigate potential NPS impacts originating from the heavy commercial and residential development in the vicinity of Westwood Center. Macroinvertebrate biomonitoring was conducted near DWM's water quality monitoring station at Summer Street; however, limited summer flows in this portion of the stream precluded quantitative sampling. A series of kicks were made in the limited and very shallow riffle areas, and occasional snags in a reach immediately upstream from the Summer Street crossing. Although land use in the upper portion of the Rock Meadow watershed is moderately-heavily residential, the segment from Stevens Pond/Lee Pond to Summer Street is almost entirely comprised of forested and undeveloped space. The riparian zone along both banks of the RM01 sampling reach, then, were completely undisturbed, and codominated by deciduous trees (*Ulmus* sp., *Acer rubrum*) and shrubs *(Viburnum dentatum*, *Cornus* sp.). Herbaceous growth (*Symplocarpus* sp., *Onoclea* sp., *Osmunda* sp.) was also present in the understory and along the margins of the stream. Instream vegetation was confined to rooted emergent forms (*Lobelia cardinalis*, *Symplocarpus* sp.). Although rocky substrates were abundant throughout the reach, shallow stream depth and lack of appreciable current velocity left (west) much of the substrates unavailable for macroinvertebrate utilization. The superb benthos habitat observed during field reconnaissance in the spring was almost completely exposed during the sampling index period. In fact, even water quality monitoring at this station was cancelled during the low flow months of summer and fall, due to inadequate water depth for grab samples and Hydrolab™ use. RM01 received a habitat assessment score of 121 out of 200 (Table C1).

BENTHOS

Results of a cursory benthos screening conducted 16 July 1997 found no signs of gross impairment to the resident aquatic community, as evidenced by the presence of pollution- sensitive EPT taxa (Table A3). Based on results from the habitat evaluation and water quality monitoring (all parameters measured were generally good) at RM01, it appears that flow is the most important issue in this portion of the Rock Meadow Brook watershed. It is unknown if the low instream flows observed during the summer and fall were a natural occurrence or the result of upstream groundwater withdrawals. Two municipal (Westwood) water supply groundwater sources (307300010-G, 307300012-G) are located in close proximity to Rock Meadow Brook, just south of the Stevens Pond impoundment. An investigation into the presence/extent of damming structures on impoundments (i.e., Stevens Pond and Lee Pond) in this watershed is recommended.

Rosemary Brook (RB01): RBP III-kick sampling conducted 16 July 1997

RB01—Rosemary Brook, Wellesley, MA

HABITAT

DWM conducted macroinvertebrate and fish biomonitoring during July 1997 in a reach delineated by Barton Road at the upstream end and the Interstate 95 crossing at its lower extent. While instream habitat in the sampling reach offered only marginal fish cover, macroinvertebrate habitat was considered excellent due to well-developed riffle areas and a variety of epifaunal substrates (submerged logs, cobble, gravel, bricks). With the exception of a footpath along the right (east) stream bank, a wide and well vegetated riparian zone extended from both sides of the channel throughout the sampling reach. Trees (*Salix* sp., *Crataegus* sp., *Ulnus rubra*, *Ramnus* sp.) dominated the riparian vegetation, although some shrubs (*Alnus* sp., *Rhus radicans*) and herbaceous forms (*Lythrum* sp., *Onoclea* sp.) were present as well. Observed NPS pollution consisted primarily of various forms of trash (plastics, tires) throughout the sampling reach, probably originating from the Barton Road crossing and/or Interstate 95. Road runoff may also contribute to the moderate levels of instream sediment deposition and embeddedness. A large stormdrain pipe discharges to this portion of the stream; however, sampling conducted by DWM indicated that dry weather discharges were benign (MA DEP 1998a). The RB01 sampling station received a habitat assessment of 135 out of a possible 200, which was fairly comparable to instream and riparian conditions at the ST01 reference station (Table C1).

BENTHOS

The macroinvertebrate community sampled received a total metric score of 12, which was only 30% comparable to the reference community. Low overall taxa richness and a reduced EPT index (Table B10), coupled with a fairly high biotic index (Table B10), suggested a benthic assemblage stressed by low levels of dissolved oxygen and organic enrichment. The dominance of the macroinvertebrate community by the chironomid *Polypedilum convictum*, which can be numerous in streams with high concentrations of suspended organic particulates (Bode and Novak 1998), further supports the enriched nature of this stream system. Fish community diversity was also lower than expected, resulting in the capture of only three species of fish (Table C2)—one of which (*Micropterus salmoides*) is not normally associated with lotic systems, and one of which (*Catostomis commersoni*) displays some tolerance of reduced oxygen. Indeed, post-dawn DO measurements taken by DWM at RB01 were as low as 3.9 mg/l at 42% saturation (MA DEP 1998a). Somewhat elevated levels of nutrients, particularly phosphorus (0.12 mg/l) and ammonia-nitrogen (0.07 mg/l) also indicate upstream sources of pollution that may contribute to enriched conditions instream (MA DEP 1998a). Nutrient loadings may be responsible for the abundance of the alga *Spirogyra* sp. observed in the pools of the RB01 reach (Table C3). The photosynthesis and respiration cycle of the algal growth may contribute to reduced oxygen levels observed at RB01. Following the growing season, the breakdown of this alga contributes organic material that can fill crevices around substrates, thus affecting the epifaunal community. Moderate levels of turbidity, probably caused by the heavy loads of sedimented or suspended material often associated with eutrophic conditions, were observed at the RB01 station as well. These fine materials can be deleterious because they can reduce light penetration and consequently plant growth (instream aquatic vegetation was minimal at RB01), smother hard surfaces, and fill interstices within the substrate (Wiederholm 1984). Resident biota at RB01, then, may be subsequently affected by obstructions in food collection or respiration caused by fine deposits of organic material.

Beaver Brook (BE02): RBP III-kick sampling conducted 17 July 1997

BE02—Beaver Brook, Belmont/Watertown, MA

HABITAT

Because habitat constraints rendered biomonitoring impractical at the DWM water quality stations, macroinvertebrate sampling was conducted further upstream in Beaver Brook Reservation near Trapelo

Road. Attempts to sample the high-gradient reach from Mill/Duck Pond to Trapelo Road—a segment with an undisturbed and forested riparian zone, and abundant large rocky substrates (boulder/cobble)—were also unsuccessful, as low flows provided only standing pools of water and riffles too shallow for kick sampling. The BE02 sampling reach was established at the footbridge near the Beaver Brook Reservation playground, and extended downstream for approximately 100 m. While substrates (small cobble/gravel) and velocity in the sampling reach provided good riffle habitat for macroinvertebrates, inadequate depth provided fish with poor cover. The many exposed cobble bars and "islands" throughout the reach were colonized by hydrophyllic grasses and herbaceous growth (*Symplocarpus foetidus*, *Impatiens capensis*). The riparian zone along the left (north) stream bank was well vegetated with a mix of deciduous trees (*Acer rubrum*, *Quercus* sp., *Ulmus* sp.); however, only a narrow strip of shrubs and trees existed between the right (south) bank and a vast expanse of mowed lawn. Just upstream from the sampling reach this riparian buffer was completely removed, resulting in obvious signs of erosion and general instability along the grassy bank. BE02 received a habitat assessment score of 127 out of 200, which was less than 80% comparable to reference conditions at ST01 and the lowest evaluation received by a Charles River watershed biomonitoring station where RBP III kick sampling was conducted (Table C1).

BENTHOS

The benthic assemblage was dominated by the chironomid *Parametriocnemus* sp., which displays only moderate tolerance of organic pollution (Table A2). Overall taxa richness was low, with very few EPT taxa represented. A total metric score of 12 was only 30% comparable to the biological attributes observed at ST01 (Table B10). While water quality impacts cannot be ruled out in this portion of Beaver Brook (i.e., there is a lack of water quality data in this portion of Beaver Brook), the apparent lack of FPOM—as indicated by the low density of filter-feeders (Table A2)—suggests that excessive organic enrichment may not shape benthic community structure and function at BE02. Rather, impairment to the aquatic community seems to be primarily the result of habitat alterations—particularly flow regulation in Beaver Brook Reservation. High densities of crayfish (order: Decopoda) were observed throughout the reach during macroinvertebrate sampling activities. The highly mobile nature of these invertebrates may make them less susceptible to periods of reduced flow that threaten other forms of benthic organisms. Site visits to the BE02 biomonitoring station a few months following sampling found the streambed completely dry from the outlet of Mill/Duck Pond to its lower reaches in the reservation—exposing what would have been superb macroinvertebrate and fish habitat. Taxa depletion, either by reduced flow-induced drift and/or the periodic loss of riffle habitat, may contribute to the low taxa richness and EPT index (score=0), and subsequent impairment to the BE02 community. The effects of organic or inorganic pollution on the biological communities at BE02 should at least be considered, as algal sampling conducted by DWM resulted in the collection of *Spirogyra* sp. and *Melosira* sp. (Table C3)—generally considered indicators of enrichment. Various sources of organic/inorganic loadings (e.g., lawn runoff, dry weather stormdrain discharges, and other forms of stormwater) may exist, as this is a fairly urbanized portion of the watershed.

It is recommended that MDC maintain suitable instream base flows downstream from Beaver Brook Reservation impoundments (i.e., Mill Pond/Duck Pond), as this portion of the stream would offer excellent macroinvertebrate habitat with additional water depth. In addition, improvements to the riparian habitat throughout the lower portion of Beaver Brook Reservation (downstream from Trapelo Road) are strongly encouraged, implementing appropriate BMP's as needed. Restoration of the vegetative riparian zone would reduce sediments, lawn runoff, and other NPS inputs to the stream; thereby, improving biological integrity in this portion of Beaver Brook.

Cheese Cake Brook (CB01): RBP I-kick sampling conducted 28 January 1998

CB01—Cheese Cake Brook, Newton, MA

HABITAT

Macroinvertebrate biomonitoring was conducted just upstream from the DWM water quality monitoring station, near Nevada Street and the confluence with the mainstem Charles River in Newton. The qualitative nature of the biomonitoring effort at CB01 precluded the need to sample during the summer index period established for the RBP III biomonitoring stations. The severely degraded riparian and instream habitat in

Cheese Cake Brook made valid biological comparisons to ST01 impossible, resulting in only a cursory assessment of biological integrity in this stream. The upper reaches of Cheese Cake Brook are entirely underground, draining a very urbanized portion of Newton. The stream emerges from a culvert at Watertown Street (Route 16) in West Newton, and remains completely channelized before joining the mainstem Charles River in the Nonantum section of Newton. All stream bank vegetation has been removed, and the banks themselves have been replaced by concrete and stone walls. Riparian vegetation is limited to narrow areas of mowed grass along both sides of the channel for the entirety of the stream reach. Adjacent to the stream and its narrow grassy margins, Albemarle Road runs the length of the stream on both sides. Bank instability, in the form of collapsing channel walls, is common along much of the stream and has led to sloughing of riparian vegetation in many areas. Massive amounts of sand are deposited throughout the stream, resulting in frequently shifting bars and embeddedness of the limited rocky substrates in the CB01 sampling reach. Nevertheless, the presence of some sand and gravel, and occasional cobble substrates, allowed for the qualitative collection of macroinvertebrates. Current velocity was adequate for macroinvertebrates in this historically "flashy" stream, although a backwater effect was observed at its confluence with the Charles River and resulted in minimal velocity at the mouth. The entire length of Cheese Cake Brook appeared extremely productive, with > 50% cover of instream aquatic vegetation, most notably duckweed (*Lemna* sp.), water starwort (*Callitriche* sp.), and burreed (*Sparganium* sp.). Many obvious sources of NPS pollution were observed along the sampling reach, including road and lawn runoff (sediments, dog and waterfowl feces), and numerous stormdrain pipes (including dry weather discharges). CB01 received a habitat assessment score of only 63 out of 200—easily the poorest habitat evaluation received by a biomonitoring station in the 1997 Charles River watershed survey (Table C1). In addition, monthly water quality monitoring by DWM (MA DEP 1998a) has revealed severely degraded conditions (elevated levels of fecal coliform bacteria, ammonia, phosphorus, and chlorides; turbidity; low dissolved oxygen; high conductance) throughout this stream.

BENTHOS

Maroinvertebrate sampling yielded taxa that generally display tolerance of organic pollution (Table A3). In addition, the high densities of Hyropsychidae observed at CB01 indicated organic enrichment and an abundance of the FPOM food resource. The absence of other more pollution-sensitive taxa is probably the result of a combination of the habitat constraints and water quality degradation prevalent throughout this stream system. Sediment deposition is probably the habitat constraint most limiting to the benthic community potential, and is exacerbated by the channelized nature of the stream, reduced vegetative buffer, excavational construction activities in the vicinity of Albemarle Park and the Watertown/Washington Street intersection, and paved swales that drain Albemarle Road. Sand and other fine sediments drastically reduce macroinvertebrate microhabitat by filling the interstitial spaces of substrates. Improvements to the riparian zone (i.e., restoration of the vegetated buffer) and implementation of BMP's would greatly help to reduce various NPS inputs to this stream. Water quality impacts that threaten biological integrity in Cheese Cake Brook originate from stormdrain discharges (wet and dry weather), dog feces, waterfowl activity, and other forms of urban runoff. Illicit sewer connections to the stormdrain system were discovered by DWM when bacteria samples taken from a dry weather discharge at Watertown Street revealed highly elevated levels (50,000 cfu/100 ml) of fecal coliform bacteria (MA DEP 1998a). Other discharges probably exist upstream from Eddy Street, where high instream levels of fecal coliform bacteria have been documented by DWM during dry weather sampling (MA DEP 1998a). Infrastructure upgrades to the Newton stormdrain system would potentially eliminate or reduce the effects of these water quality stressors. In addition, a municipal golf course near Albemarle Park may contribute to nutrient loadings to this portion of the stream.

RECOMMENDATIONS

Groundwater Withdrawals/Flow Reduction

BB04 (Bogastow Brook)—As the upstream control for BB04A, this station displayed good overall biological integrity. Habitat quality was generally good; however, moderate levels of instream deposition and shifting sandbars were observed throughout the sampling reach. The Fiske Street crossing appears to be the source of sediment inputs, and implementation of BMP's here may help reduce sediment loads to this portion of the stream.

BB04A (Bogastow Brook)—Although gross impairment to the aquatic community downstream from the Bogastow Brook groundwater well appeared absent, additional benthos data collections and comparisons to BB04 over the next several years may be more revealing and are recommended before making a definitive assessment of water withdrawal impacts in this stream. Biomonitoring, habitat assessments, and flow gauging are recommended during the next round of monitoring activities in the Charles River watershed.

MR01 (Mill River)—Biomonitoring was conducted here to establish baseline biological conditions (as the reference station) prior to the commencement of water withdrawals just downstream. Macroinvertebrate sampling at MR01 is planned for the next "year 2 phase" in the basin cycle for the Charles River watershed. Flow gauging should accompany future biological and habitat assessments.

MR02 (Mill River)—Biomonitoring was conducted here to establish baseline biological conditions (as the study station) prior to the commencement of water withdrawals just upstream. Macroinvertebrate sampling at MR02 is planned for the next "year 2 phase" in the basin cycle for the Charles River watershed, thus, providing trend monitoring data to assess the impacts of the Mill River Well on downstream aquatic communities. Flow gauging should accompany future biological and habitat assessments.

MB01 (Miscoe Brook)—Low flows precluded biomonitoring of any kind at MB01, originally planned to establish baseline biological conditions downstream of the proposed Franklin State Forest Well in the Miscoe Brook headwaters. If this groundwater withdrawal is in fact established, future attempts to bracket the reduced flow effects on the biological community should be considered.

MB02 (Mine Brook)—Considerable amounts of trash and sediment were observed instream, no doubt originating from the poorly buffered left (west) bank and the adjacent road. Runoff from the upstream road crossing (Route 140) was also an obvious source of NPS pollution, contributing to moderate levels of instream embeddednes and deposition. Improvements to, or restoration of, the riparian zone along this portion of Mine Brook would help reduce NPS inputs from the left bank. BMP implementation at the Route 140 crossing may minimize sediment loads as well.

DB01 (Dopping Brook)—If approved, future water withdrawals from this already stressed aquifer may have a negative impact on the resident biota at DB01. The well-represented pollution-sensitive taxa observed at DB01 may be particularly susceptible to further reductions in base flow to this portion of Dopping Brook.

JB01 (Jar Brook)—While flow reduction is a perceived problem in this stream, serious NPS-induced habitat degradation may contribute most to the impairment of biological integrity in this portion of Jar Brook. Trash and yard waste enter the stream from numerous abutting residences, while heavy deposits of sand probably originate from road crossings. Outreach efforts are recommended to educate residents on how improper waste disposal impacts aquatic life in "their own back yard." Compost bins (supplied "at cost" by Conservation Commision?) would greatly assist with proper and environmentally friendly waste disposal. BMP's may reduce sediment loadings from road crossings in this heavily developed portion of the watershed. Future water quality monitoring is recommended at JB01 to determine the extent that water quality may be limiting to biological integrity in this stream. Septic system failure, and various forms of urban runoff are potential causes of water quality degradation that may need to be addressed.

Additional biomonitoring:

Charles River—Future habitat and biological assessments are recommended in the Charles River at Norfolk Road in Millis and Forest Road in Millis/Medfield, bracketing potential low-flow effects from the proposed Paine Property groundwater wells. If activated, these wells will withdraw water just downstream from the already stressed Populatic Pond/Charles River aquifers near the Medway/Franklin border. Field

reconnaissance has found this wadeable portion of the Charles River to be appropriate for RBP III kick sampling and habitat evaluations. Flow measurements should accompany monitoring activities.

Charles River—Habitat and biological assessments are recommended in the mainstem Charles River between Elm Bank and the confluence with Trout Brook to investigate potential impacts of the Elm Bank (2 wells) and Needham (3 wells) groundwater withdrawals on instream biological integrity. These large groundwater wells (0.21 cfs/m limits) are of concern to both DWS and the EOEA Charles River Basin Team.

Water Quality Impacts/Point Source Pollution

Reach 1, Reach 2, and Reach 3 (Charles River)—As called for in the Charles River Monitoring Project, ENSR will continue to conduct yearly biological monitoring upstream (Reach 1) and downstream (Reach 2 and 3) from the Milford WWTP/MPLP facilities. DWM will continue to review and analyze these benthos data, making the necessary management decisions. Based on the most recent biological data collected by ENSR, DWM found no discharge impacts to downstream aquatic communities in this portion of the Charles River. However, overall impairment to both upstream and downstream communities was evident, probably the result of stormwater, illicit sewer connections, and other forms of urban runoff in the vicinity of downtown Milford. It is recommended that future biomonitoring be conducted upstream from Milford, to establish reference conditions for future biological investigations in this segment of the Charles River which will help in making aquatic life use assessments and management decisions. Habitat evaluations should accompany any biomonitoring efforts in this segment. If a suitable mainstem control station can not be located (i.e., due to incomparable habitat quality, flow regimes, etc.), use of a regional reference site should be considered.

CR03 (Charles River)—none

CR04 (Charles River)—Despite the excellent habitat available, the benthic community at CR04 was significantly degraded, with macroinvertebrates structured in response to organic enrichment, low levels of dissolved oxygen, and nutrient loadings. A review of the Charles River Pollution Control District's discharge permit is recommended. In addition, DWM should continue to monitor the CRPCD effluent for acute and chronic toxicity, initiating toxicity identification and reduction evaluations if the facility continues to fail its permit limits.

Biological monitoring should again be conducted downstream from CRPCD during the next "year 2 phase" in the 5-year basin cycle for the Charles River watershed. Future sampling efforts should consider deployment of suspended Hester-Dendy artificial substrate samplers immediately upstream and downstream from the discharge, which would allow for a more "tightly" bracketing of the CRPCD discharge and thereby eliminate the effects of Populatic Pond.

CR05 and **CR06** (Charles River)—DWM found no discernible differences between macroinvertebrate communities upstream (CR05) and downstream (CR06) from the Medfield POTW discharge. However, benthic community structure and function at both stations indicate an assemblage structured in response to organic enrichment, reduced oxygen, and nutrients. Sources of impairment probably originate further upstream in the form of combined discharge effects from Stop River point sources and the CRPCD. To more accurately assess the status of aquatic life in this portion of the Charles River (for 305b assessment purposes), benthic communities should be compared to a suitable mainstem reference station—perhaps established upstream from Milford. If a suitable mainstem control can not be located (i.e., due to incomparable habitat quality, flow regimes, etc.), use of a regional reference site should be considered. It is also advisable that DWM continues to monitor the Medfield POTW effluent for acute and chronic toxicity, initiating toxicity identification and reduction evaluations if the facility continues to fail its permit limits. In addition, a large sand and gravel operation near Route 109 in Millis may be another source of anthropogenic impact to the biological integrity of this river segment. Though probably not a high priority, a site visit to this facility is recommended to determine if sediment loadings may impact this portion of the river.

SR01 (Stop River)—Biological integrity appeared good in this headwater segment of Stop River. Site visits are suggested to determine the source of sediment deposition to this portion of the stream; however, this is probably a low priority relative to other issues in this watershed. The Pine Street road crossing in Norfolk, or the sand and gravel operation just upstream from Pine Street, are the likeliest sources.

SR02 (Stop River)—Serious degradation to biological integrity in this portion of Stop River probably is the result of the combined effects of upstream point sources; however, Highland Lake may shape the structure and function of downstream communities as well. DWM should review existing NPDES permit limits for Southwood Community Hospital and Wrentham State School, note compliance or violations, and make recommended modifications where necessary. Site visits are recommended to both wastewater facilities. If future biological monitoring is considered in this segment, modifications to the sampling design should include more tightly bracketing of discharges so as to "tease out" potential impoundment effects.

SR03 (Stop River)—Results of site-specific biological monitoring (upstream-downstream comparisons) found that the MCI discharge does not noticeably contribute to degradation of the downstream community at ST03. However, the moderate impairment evaluation for the SR03 macroinvertebrate community relative to both the regional reference station ST01 and the upstream reference station SR01 suggests that organic enrichment—probably resulting from the combined effects of all upstream point source inputs to the Stop River—shapes benthic community structure and function in this portion of the river. In lieu of reliable dissolved oxygen data for this stream, future monitoring of diurnal DO levels is recommended. Habitat degradation observed in the SR03 sampling reach—most notably in the form of sediment deposition—could be minimized by implementing BMP's at the Noon Hill Avenue crossing.

Water Quality and Habitat Impacts/Nonpoint Source Pollution

CR00 (Charles River)—Biomonitoring should be conducted here again during the next monitoring phase for the Charles River watershed. It would be useful to supplement benthos data with diurnal dissolved oxygen data.

WB01 (Waban Brook)—Although not a high priority, better dissolved oxygen data (diurnal) and biomonitoring data (RBP III if flows are adequate) would be useful for future assessments of aquatic life use in this stream.

FB02 (Fuller Brook)—Moderate impairment to the FB02 aquatic community (macroinvertebrates and periphyton) appears to be a direct result of waterfowl activities in the Wellesley town hall duckpond at Route 16, just upstream from the FB02 sampling reach. The feeding of ducks and geese here is strongly discouraged, as organic waste from feces contributes to excessive nutrient and organic enrichment, high fecal coliform bacteria levels, and subsequent water quality and benthos impairment in this portion of Fuller Brook. The unnamed tributary which drains the town hall duckpond also appears to be seriously degraded in terms of water quality, habitat quality (resulting from deposits of FPOM), and biological quality. Biomonitoring and water quality sampling should be conducted here again during the next monitoring phase for the Charles River watershed, presumably after remedial actions have taken place.

TB01 (Trout Brook)—Manure piling may pose a threat to biological integrity in this portion of Trout Brook; however, an additional unknown stressor(s) appears to contribute to the impaired benthos assemblage at TB01. An investigation into the possible application of pesticides and fertilizers by the adjacent farm (at Haven Street) is strongly recommended. Other potential sources of nutrient enrichment or other sources of impairment are unknown, although the Charles River Basin Team may wish to conduct exploratory field reconnaissance throughout this sub-basin. Biomonitoring and water quality sampling should be conducted here again during the next monitoring phase for the Charles River watershed.

PB01 (Powissett Brook)—It is unknown whether benthos impairment at PB01 is the result of naturally-occurring low flows or exacerbated by the damming of upstream impoundments. An investigation into the presence/extent of damming structures on impoundments in this watershed is recommended. Although not a high priority, additional physico-chemical data would help in making future assessment decisions in this stream.

AB01 (Alder Brook)—Attempts should be made to isolate land use activities in this system which may contribute to instream organic/nutrient inputs that adversely affect biological integrity. The implementation of BMP's is recommended where runoff may pose a threat to water quality (e.g., non-buffered recreational spaces adjacent to the stream) or habitat quality (e.g., South Street crossing).

RM01 (Rock Meadow Brook)—Although not a high priority, diurnal DO monitoring is recommended near the mouth to establish baseline conditions which will aid in future aquatic life use assessments.

RB01 (Rosemary Brook)—Impairment to the aquatic community (macroinvertebrates and fish) was primarily due to water quality degradation in this portion of the stream. Attempts should be made to locate sources of organic enrichment, elevated nutrient levels, turbidity, and low dissolved oxygen levels documented by DWM at the RB01 station.

ST01 (Stony Brook)—As a regional reference station for Charles River watershed tributary biomonitoring stations, biological integrity and habitat quality here were considered excellent. Slight instream deposition probably is the result of road runoff from the Church Street crossing, just upstream from the sampling reach. Improvements to the street curb at this road crossing would prevent significant amounts of sand from entering the stream.

BE02 (Beaver Brook)—Impairment to the BE02 macroinvertebrate community appears to be primarily the result of habitat and flow modifications in Beaver Brook Reservation. The MDC is urged to maintain suitable instream base flows downstream from Beaver Brook Reservation impoundments (i.e., Mill Pond/Duck Pond), as this portion of the stream would offer superb macroinvertebrate habitat. Improvements to the riparian zone throughout the lower portion of Beaver Brook Reservation is also recommended, particularly just downstream from Trapelo Road where riparian vegetative habitat has been greatly reduced.

CB01 (Cheese Cake Brook)—Impairment to the benthic community at CB01—and probably throughout Cheese Cake Brook—is a result of both serious habitat and water quality degradation. Probably the greatest effort should go into locating/isolating sources of elevated fecal coliform bacteria and nutrient inputs to the stream, making necessary infrastructure upgrades to eliminate illicit sewer connections and dry weather stormdrain discharges to the stream. Of particular concern is the stormdrain outfall located just upstream from Watertown Street, although several other discharges may exist upstream from Eddy Street throughout the underground portion of this stream.

Habitat improvements are recommended throughout the entire "above ground" segment of Cheese Cake Brook. The implementation of BMP's, especially to prevent road runoff and sediment inputs to the portion of Cheese Cake Brook along Albemarle Road, is highly recommended. In addition, the restoration of a riparian vegetative zone—presently removed—may help prevent sand and other NPS inputs from entering the stream. Repairs to collapsing segments of the walled stream bank (especially near the mouth of the stream) may also reduce bank erosion and sediment inputs by improving bank stability. Site visits may help to determine the extent—if any—that excavational construction activities in the vicinity of Albemarle Park and the Watertown Street/Washington Street intersection may be having on sediment loadings. Finally, residents should be encouraged to properly dispose of pet feces (especially from dogs), especially in the vicinity of Albemarle Road where there is a minimal riparian buffer against NPS inputs. Goose activity has also been observed in this portion of the stream, and the feeding of geese by residences of this neighborhood is strongly discouraged.

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Appendix A (1997 Charles River Watershed Biological Monitoring)

Taxa Lists tor Macroinvertebrate Samples Collected During the 1997 Charles River Watershed Survey.

Table A1. Species-level taxa list and counts, functional feeding groups (FFG), and tolerance values (TV) for macroinvertebrates collected from stream sites in the Charles River watershed between 21 August 1997 and 3 September 1997. Sampling stations were in: Bogastow Brook (BB04; BB04A), Mill River (MR01; MR02), and the Charles River (CR05; CR06). The macroinvertebrate collection procedure utilized the deployment of triplicate Hester-Dendy multiplate samplers. Samplers were colonized for a period of eight weeks.

TAXON	FFG [1]	TV [2]	BB04 (#1)	BB04 (#2)	BB04 (#3)	BB04A (#1)	BB04A (#2)	BB04A (#3)	MR01 (#1)	MR01 (#2)	MR01 (#3)	MR02 (#1)	MR02 (#2)	MR02 (#3)	CR05 (#1)	CR06 (#1)	CR06 (#2)	CR06 (#3)
Gastropoda	SC	6			1													
Laevapex fuscus	SC	7	2	4	6	1	2											
Hydrobiidae	SC	8		1		2	3	1	1	2	2	9	4	1				
Physidae	GC	8			2			1					1					
Planorbidae	SC	6									3	11	6	1	1	2		1
Helisoma trivolvis	SC	6					1											
Sphaerium sp.	FC	6			1													
Nais sp.	GC	9										1						
Nais communis	GC	8	1															
Glossiphoniidae	PR	7											2	1				
Helobdella stagnalis	PR	7														2		
Caecidotea communis	GC	8	13	9	32	18	14	11				45	43	50				
Gammarus sp.	GC	6	16	12	12	1	3	4	14	10	17		1	1				1
Hyalella azteca	GC	8				6	1	13				20	30	24	9	9	2	1
Heptageniidae	SC	4						1	3						1	4	2	2
Stenonema sp.	SC	3	2	1			2	1	23	35	18					2	2	4
Stenonema femoratum	SC	8														2		
Stenacron sp.	SC	7	8	10		5		2							1	2		
Stenacron interpunctatum	SC	7			19		9											
Tricorythodes sp.	GC	5							27	25	38	4						1
Caenidae	GC	7																1
Caenis sp.	GC	8											1		2	1		
Leptophlebiidae	GC	2			3	1												
Paraleptophlebia sp.	GC	1			1	10	3	5				1						
Basiaeschna sp.	PR	7				2							1					
Basiaeschna janata	PR	8									1							
Macromia sp.	PR	7										1						
Calopterygidae	PR	5						1										
Calopteryx sp.	PR	8			1					1								
Hetaerina sp.	PR	6	1		1													
Coenagrionidae	PR	9							2	1			2	1		2	3	4
Argia sp.	PR	9	1	1	5					1			1					

TAXON	FFG [1]	TV [2]	BB04 (#1)	BB04 (#2)	BB04 (#3)	BB04A (#1)	BB04A (#2)	BB04A (#3)	MR01 (#1)	MR01 (#2)	MR01 (#3)	MR02 (#1)	MR02 (#2)	MR02 (#3)	CR05 (#1)	CR06 (#1)	CR06 (#2)	CR06 (#3)
Epitheca sp.	PR	8																1
Sialis sp.	PR	8			1	13	2	7						1				1
Nigronia sp.	PR	6	2	1														
Trichoptera	GC	5	1															
Polycentropodidae	FC	6			4													
Cemotina sp.	PR	5		3														
Neureclipsis sp.	FC	4																1
Lype sp.	SC	3		1														
Hydropsychidae	FC	4														1		
Cheumatopsyche sp.	FC	7																12
Hydroptilidae	GC	4							2	3	1							
Agraylea sp.	GC	8							4									
Oxyethira sp.	GC	3													2			
Limnephilidae	SH	4						1										
Discosmoecus sp.	SH	4		1	1													
Pycnopsyche sp.	SH	2	1	1	1	1		3										
Oecetis sp.	PR	6								1		1					2	
Triaenodes sp.	SH	6																1
Ancyronyx sp.	GC	7														15		
Ancyronyx variegata	GC	7	1					1									23	4
Macronychus glabratus	SH	5			1		2			1	2							1
Stenelmis sp.	SC	5							1	3	1					1		
Stenelmis crenata gr.	SC	5						1										
Chironomidae	GC	6						1										
Tanypodinae	PR	7			1										1			1
Ablabesmyia sp.	PR	8	1		1				1			1	3	1	10	4	3	2
Conchapelopia sp.	PR	9	1	1	2			1										
Labrundinia sp.	PR	6									1							
Pentaneura sp.	PR	5							1							2	3	7
Thienemannimyia gr.	PR	6														1		
Orthocladiinae	GC	5	1				1											
Corynoneura sp.	GC	6										1						
Cricotopus sp.	SH	7							1		1							
Cricotopus/Orthocladius sp.	GC	7				1			1									
Cricotopus tremulus gr.	SH	7							1									

TAXON	FFG [1]	TV [2]	BB04 (#1)	BB04 (#2)	BB04 (#3)	BB04A (#1)	BB04A (#2)	BB04A (#3)	MR01 (#1)	MR01 (#2)	MR01 (#3)	MR02 (#1)	MR02 (#2)	MR02 (#3)	CR05 (#1)	CR06 (#1)	CR06 (#2)	CR06 (#3)
Orthocladius sp.	GC	6								1								
Parametriocnemus sp.	GC	5			1													
Thienemanniella sp.	GC	6								1								
Chironominae	GC	6																1
Chironomus sp.	GC	10			1							1						
Goeldichironomus sp.	GC	8													1			
Cryptotendipes sp.	GC	6							1									
Dicrotendipes sp.	GC	8	1	3		2	4	4	1	2	2	3	1	2	11			1
Einfeldia sp.	GC	9	2															
Endochironomus sp.	SH	10	1												18	6	2	1
Glyptotendipes sp.	SH	9				1									40	21	33	39
Kiefferulus sp.	GC	10				1												
Microtendipes sp.	FC	6			2			1	1				2		3			
Phaenopsectra sp.	SC	7				1					1		2					
Polypedilum sp.	SH	6			1		1		2						2	6		
Polypedilum convictum	SH	5							6	3	2							
Polypedilum fallax gr.	SH	6	2	2	3	1	1						1					
Polypedilum illinoense	SH	9							1									
Pseudochironomus sp.	GC	5									1							
Stenochironomus sp.	GC	6													3	7	14	5
Tribelos sp.	GC	7					1	1					4					
Micropsectra sp.	GC	1				1	1	1										
Paratanytarsus sp.	FC	8				2		1	1	1					3		9	
Rheotanytarsus sp.	FC	6														1		
Rheotanytarsus distinctissimus gr	FC	6	1						1									
Stempellinella sp.	GC	4			3	1	2	4										
Tanytarsus sp.	FC	7	31	10	21	24	6	32	5	5	9	9	4	9	1	3	9	8
Tanytarsus/Micropsectra sp.	GC	4		1		5		1			1							
Zavrelia sp.	FC	3						1										
Hemerodromia sp.	PR	6							1									
TOTAL			90 [3]	62 [3]	128 [3]	100 [3]	59 [3]	101 [3]	102	96	101	108	109	92	109	94	107	101

[1] Functional Feeding Group (FFG) lists the primary feeding habit of each taxa and follows the abbreviations: SH-Shredder; GC-Gathering Collector; FC-Filtering Collector; SC-Scraper; PR-Predator.

[2] Tolerance Value (TV) is an assigned value used in the calculation of the biotic index. Tolerance values range from 0 for organisms very intolerant of organic wastes to 10 for organisms very tolerant.

[3] Original sample picked through entirely (i.e. not subsampled due to low organism abundance).

Table A2. Species-level taxa list and counts, functional feeding groups (FFG), and tolerance values (TV) for macroinvertebrates collected from stream sites in the Charles River watershed between 8 July and 21 August 1997. Sampling stations were in: Charles River (CR03, CR04, CR00), Stop River (SR01, SR02, SR03), Stony Brook (ST01), Trout Brook (TB01), Rosemary Brook (RB01), Beaver Brook (BE02), Alder Brook (AB01), Fuller Brook (FB02), Powissett Brook (PB01), Mine Brook (MB01). The macroinvertebrate collection procedure utilized kick sampling.

TAXON	FFG[1]	TV[2]	CR03	CR04	CR00	SR01	SR02	SR03	ST01	TB01	RB01	BE02	AB01	FB02	PB01	MB02
Gastropoda	SC	6	1													
Physidae	GC	8										1		2		
Pisidiidae	FC	6			2		58	5								
Pisidium sp.	FC	7		3							3		1		1	1
Lumbricina	GC	8	1									1				
Enchytraeidae	GC	10			2							2				
Tubificidae	GC	10									3	1	2			
Naididae	GC	9			1											
Nais behningi	GC	6	1					1								
Nais communis	GC	8							6							
Pristina leidyi	GC	8										1				
Pristinella osborni	GC	10							1							
Lumbriculidae	GC	7														
Lumbriculus sp.	GC	8	2			6				6	1		2			5
Glossiphoniidae	PR	7			1											
Caecidotea communis	GC	8				2		2			4	13	1		1	
Gammarus sp.	GC	6		5	1				1	1	2					
Hyalella azteca	GC	8						2		1	5		1			
Hydracarina	PR	6	1		4						1					1
Ephemeroptera	GC	5				5				1						
Baetidae	GC	4	2	5	4	3			1							
Baetis sp.	GC	6	10		4											1
Isonychia sp.	FC	4	3						1							

TAXON	FFG[1]	TV[2]	CR03	CR04	CR00	SR01	SR02	SR03	ST01	TB01	RB01	BE02	AB01	FB02	PB01	MB02
Heptageniidae	SC	4	1	1				2	1	2					2	1
Stenonema sp.	SC	3				1		1								4
Serratella deficiens	GC	3							10							
Tricorythodes sp.	GC	5		8				1								
Calopteryx sp.	PR	8				1										
Leuctra sp.	SH	1				2				2						
Attaneuria sp.	PR	3							2							
Perlesta sp.	PR	0							1							
Nigronia sp.	PR	6							2						1	4
Chimarra sp.	FC	3	6	6	17	2			8	1					7	6
Dolophilodes sp.	FC	1							28							
Lype diversa	GC	2				1										
Hydropsychidae	FC	4	7	3	6	3		6	7		7	1	13	12		5
Cheumatopsyche sp.	FC	5		9	17	1	7	50	1	1	10	3	26	40	3	
Diplectrona modesta	FC	2				1									1	
Hydropsyche sp.	FC	4				4	1			5						
Hydropsyche betteni gr.	FC	8	2	7	9	1	2	20	9	5	5	1	9	3	3	19
Hydropsyche morosa gr.	FC	6	23													
Macrostemum sp.	FC	4	2													
Glossosoma sp.	SC	2				2			4	1						
Protoptila sp.	SC	3	4													
Hydroptila sp.	GC	6	1													2
Micrasema sp.	SH	2							2							1
Neophylax sp.	SC	2														3
Pycnopsyche sp.	SH	2								1						
Psilotreta sp.	SC	0													1	
Setodes sp.	GC	1					1									
Leptoceridae	PR	4														1
Ectopria nervosa	SC	4							1							
Psephenus herricki	SC	3	1													
Elmidae	GC	4	1													

TAXON	FFG[1]	TV[2]	CR03	CR04	CR00	SR01	SR02	SR03	ST01	TB01	RB01	BE02	AB01	FB02	PB01	MB02
Dubiraphia sp.	GC	6						1								
Optioservus sp.	SC	3	1													
Oulimnius sp.	SC	2	7													
Oulimnius latiusculus	SC	2								6						1
Promoresia sp.	SC	2							4							17
Promoresia tardella	SC	0							1							
Stenelmis sp.	SC	5		1		1	10	1			20	4	12	5	8	8
Stenelmis crenata	SC	5				1				1		2	1			1
Antocha sp.	GC	5														1
Dicranota sp.	PR	0				1										
Tipula sp.	SH	8				2		1			1			1		
Cnephia dacotensis	FC	4								1						
Simulium sp.	FC	4											1			
Simulium nyssa	FC	5	1	1												
Simulium tuberosum complex	FC	4		1												
Simulium tuberosum	FC	4	12	1		13				1						
Simulium vittatum complex	FC	9		7												
Simulium vittatum	FC	9		29	1									9		
Chironomidae	GC	6			1											
Tanypodinae	PR	7										1			1	
Ablabesmyia sp.	PR	8		1						1						
Monopelopia sp.	PR	7													1	
Conchapelopia sp.	PR	9			1			1	1			6	4	1	3	3
Krenopelopia sp.	PR	7				1										
Pentaneura sp.	PR	5		3	1			1								
Thienemannimyia gr.	PR	6				1		1							1	
Diamesinae	GC	2					1					1	1			1
Diamesa sp.	GC	8										2				
Sympotthastia sp.	GC	6							2							
Orthocladiinae	GC	5										1				
Brillia sp.	SH	5														1
Brillia flavifrons	SH	5							1							
Brillia parva	SH	5				1										

TAXON	FFG[1]	TV[2]	CR03	CR04	CR00	SR01	SR02	SR03	ST01	TB01	RB01	BE02	AB01	FB02	PB01	MB02
Cardiocladius sp.	PR	6			2											
Corynoneura sp.	GC	6					1		1							
Cricotopus sp.	SH	7												1		
Diplocladius sp.	GC	8				1						3				
Eukiefferiella claripennis gr.	GC	8										1				
Eukiefferiella devonica gr.	GC	4								3						
Metriocnemus sp.	GC	5										2				
Nanocladius sp.	GC	7												1		
Orthocladius sp.	GC	6			1											
Parakiefferiella sp.	GC	6														1
Paralimnophyes sp.	GC	4										1				
Parametriocnemus sp.	GC	4				8			2	6		45			1	9
Paraphaenocladius sp.	GC	4							1	1		1				
Rheocricotopus sp.	GC	6												1		
Symposiocladius lignicola	SH	5							2							
Thienemanniella sp.	GC	6							1							
Tvetenia sp.	GC	5	1		1					1						
Tvetenia bavarica gr.	GC	5				9			8	48	1	2	3			3
Tvetenia vitracies gr.	GC	5		3	6											
Chironominae	GC	6				1				1						
Chironomini	GC	6	1												1	
Cryptochironomus sp.	PR	8													1	
Microtendipes sp.	FC	6	1	1				1								
Microtendipes pedellus gr.	FC	6							1							
Phaenopsectra sp.	SC	7											1			
Polypedilum sp.	SH	6										1				
Polypedilum aviceps	SH	4													6	
Polypedilum convictum	SH	5		5	4		16				36		3	3	3	
Polypedilum illinoense	SH	9							1					2		
Polypedilum obtusum	SH	6									1					
Polypedilum scalaenum	SH	9			3							1				
Polypedilum simulans/digitifer	SH	6													1	
Polypedilum trigonum	SH	6												1		
Micropsectra sp.	FC	1				14				4		1	7	15	42	1

TAXON	FFG[1]	TV[2]	CR03	CR04	CR00	SR01	SR02	SR03	ST01	TB01	RB01	BE02	AB01	FB02	PB01	MB02
Micropsectra/Tanytarsus sp.	FC	4				1									6	
Paratanytarsus sp.	FC	8											1			
Rheotanytarsus distinctissimus gr.	FC	6	3	3	1	12	1	4								2
Rheotanytarsus exiguus gr.	FC	6	1	3		2		2	1				9			2
Tanytarsus sp.	FC	7			3			1		3			1		9	
Chelifera sp.	PR	6				1				2						
Hemerodromia sp.	PR	6	3				4	1			1	3			1	
TOTAL			100	106	93	105	102	105	113	106	101	102	99	97	105	105

[1] Functional Feeding Group (FFG) lists the primary feeding habit of each species and follows the abbreviations: SH-Shredder; GC-Gathering Collector; FC-Filtering Collector; SC-Scraper; PR-Predator.

[2] Tolerance Value (TV) is an assigned value used in the calculation of the biotic index. Tolerance values range from 0 for organisms very intolerant of organic wastes to 10 for organisms very tolerant.

Table A3. List of macroinvertebrates collected (qualitatively) from stream sites in the Charles River watershed between 10 July 1997 and 28 January 1998. Sampling stations were in Jar Brook (JB01), Dopping Brook (DB01), Rock Meadow Brook (RM01), Cheese Cake Brook (CB01), and Waban Brook (WB01). Taxon presence at a station is marked with an "X".

TAXON	FFG [1]	TV [2]	JB01	DB01	RM01	CB01	WB01
Hydrobiidae	SC	8			X		
Lymnaeidae	GC	6	X				X
Planorbidae	SC	6	X				
Physidae	GC	8		X	X	X	
Pisidiidae	FC	6		X	X		
Lumbricina	GC	8	X			X	X
Enchytraeidae	GC	10	X				
Lumbriculidae	GC	8	X				
Tubificidae	GC	10				X	
Erpobdellidae	PR	8			X		
Glossiphoniidae	PR	7		X			
Asellidae	GC	8	X				
Crangonyctidae	GC	8				X	
Gammaridae	GC	6		X			
Heptageniidae	SC	4					X
Aeshnidae	PR	6	X		X		
Perlodidae	PR	2	X				
Corydalidae	PR	5		X			X
Sialidae	PR	4		X			
Hydropsychidae	FC	4			X	X	X
Lepidostomatidae	SH	1		X			
Limnephilidae	SH	4		X			
Philopotamidae	FC	3			X		X
Rhyacophilidae	PR	0		X			
Uenoidae	SC	2			X		
Elmidae	SC	4					X
Dytiscidae	PR	5	X				
Tipulidae	SH	3	X				
Simuliidae	FC	6	X				
Chironomidae	GC	6	X		X	X	X

[1] Functional Feeding Group (FFG) lists the primary feeding habit of each species and follows the abbreviations: SH-Shredder; GC-Gathering Collector; FC-Filtering Collector;
SC-Scraper; PR-Predator.
[2] Tolerance Value (TV) is an assigned value used in the calculation of the biotic index. Tolerance values range from 0 for organisms very intolerant of organic wastes to 10 for organisms very tolerant.

Appendix B (1997Charles River Watershed Biological Monitoring)

Data Analyses for Macroinvertebrate Samples Collected During the 1997 Charles River Watershed Survey

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Table B1. Summary of data analysis for macroinvertebrate communities sampled in Bogastow Brook between 10 July and 21 August 1997. Seven biological metrics were calculated for taxa collected from each triplicate sample. Mean metric values for downstream samplers (BB04A) were compared to those for the upstream reference station (BB04) using both the Student's t-test and the Mann-Whitney Test. The t-statistic values and Mann-Whitney Test U-statistic values are included in the table and are used as the basis for evaluation of impairment. Bold-faced statistic values indicate significant (≥ critical magnitude at 0.05 significance) differences between means.

STATION #	BB04-1	BB04-2	BB04-3	MEAN	ST. DEV.	SCORE	BB04A-1	BB04A-2	BB04A-3	MEAN	ST. DEV.	SCORE	t STATISTIC	U STATISTIC
	BOGASTOW BROOK (UPSTREAM)						BOGASTOW BROOK (DOWNSTREAM)							
HABITAT SCORE	113						131							
TAXA RICHNESS	20	16	23	20	3.50	NA	21	18	22	20	2.00	NA	0	4.0
BIOTIC INDEX	6.87	6.63	6.90	6.80	0.15	NA	6.52	6.56	6.50	6.53	0.03	NA	**3.13**	**9.0**
EPT INDEX	4	6	5	5.00	1.00	NA	3	3	4	3.00	1.00	NA	2.45	6.5
EPT/CHIRONOMIDAE	0.29	1.00	0.81	0.70	0.37	NA	0.43	0.82	0.27	0.51	0.28	NA	0.71	6.0
SCRAPERS/FILTERERS	0.38	1.70	0.93	1.00	0.66	NA	0.35	2.67	0.17	1.06	1.39	NA	0.07	6.0
% DOMINANT TAXON	34%	19%	25%	0.26	0.08	NA	24%	24%	32%	0.27	0.05	NA	0.16*	5.0*
COMMUNITY SIMILARITY(CC) INDEX	1.00	1.00	1.00	1.00	0.00	NA	0.39 0.54 0.45	0.42 0.47 0.54	0.43 0.53 0.44	0.47	0.06	NA	**15.3**	**9.0**
TOTAL METRIC SCORE				NA						NA				
% COMPARABILITY TO REFERENCE STATION										NA				
BIOLOGICAL CONDITION-DEGREE IMPAIRMENT				REFERENCE **(upstream control)**						**NONIMPAIRED**				

* based on arcsine transformed values (not shown) which normalize the distribution of variates.

Table B2. Data matrices for ordination of similarities calculated from the coefficient of community (cc) index for macroinvertebrates on Hester-Dendy multiplate samplers. The cc index was compared both among triplicate samplers and between triplicate samplers for the BB04 and BB04A stations.

Data matrix 1:

station	BB04-1	BB04-2	BB04-3	BB04A-1	BB04A-2	BB04A-3
BB04-1	-	.67	.47	.39	.42	.43
BB04-2		-	.46	.54	.47	.53
BB04-3			-	.45	.54	.44
BB04A-1				-	.62	.65
BB04A-2					-	.60
BB04A-3						-

Data matrix 2:

station	BB04-1, BB04-2		BB04-3	BB04A-1	BB04A-2	BB04A-3
BB04-1	-		.47	.39	.42	.43
BB04-2			.46	.54	.47	.53
BB04-3			-	.45	.54	.44
BB04A-1				-	.62	.65
BB04A-2					-	.60
BB04A-3						-

Data matrix 3:

station	BB04-1, BB04-2		BB04-3	BB04A-1, BB04A-3	BB04A-2
BB04-1	-		.47	.41	.42
BB04-2			.46	.54	.47
BB04-3			-	.45	.54
BB04A-1 BB04A-3				-	.61
BB04A-2					-

Data matrix 4:

station	BB04-1, BB04-2		BB04-3	BB04A-1,BB04A-2,BB04A-3
BB04-1	-		.47	.42
BB04-2			.46	.51
BB04-3			-	.50
BB04A-1 BB04A-2 BB04A-3				-

Data matrix 5:

station	BB04-1, BB04-2		BB04-3	BB04A-1 BB04A-2 BB04A-3
BB04-1 BB04-2	-		.47	.46
BB04-3			-	.48
BB04A-1 BB04A-2 BB04A-3				-

Data matrix 6:

station	BB04-1, BB04-2	BB04-3, BB04A-1, BB04A-2, BB04A-3
BB04-1 BB04-2	-	.46
BB04-3 BB04A-1 BB04A-2 BB04A-3		-

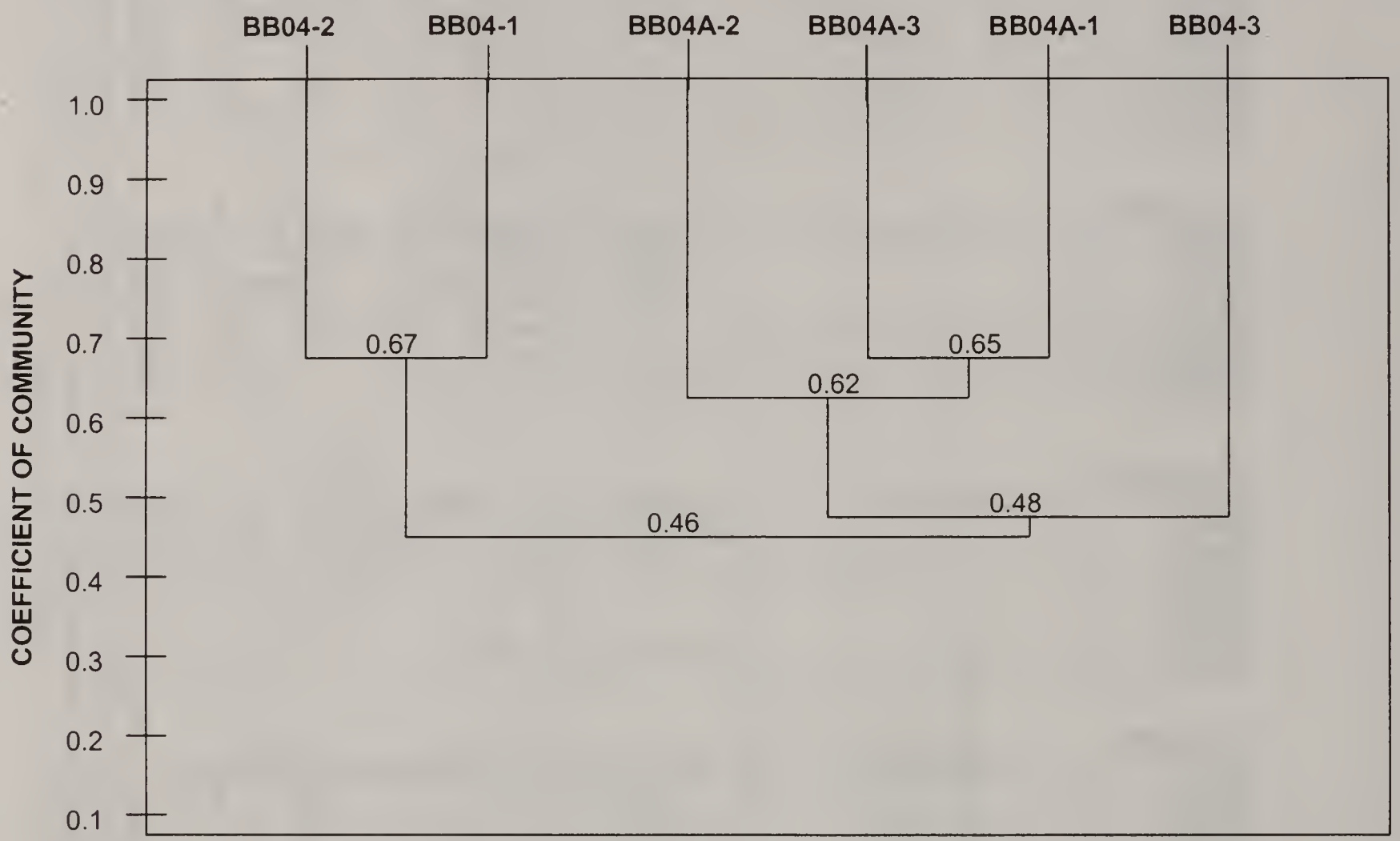

Figure B1. Ordination of community similarities for macroinvertebrates on Hester-Dendy multiplate samplers at Bogastow Brook.

Table B3. Summary of data analysis for macroinvertebrate communities sampled in Mill River between 9 July and 2 September 1997. Eight biological metrics were calculated for taxa collected from each triplicate sample. Mean metric values for downstream samplers (MR02) were compared to those for the upstream reference station (MR01) using the Student's t-test and the Mann-Whitney Test. The t-statistic values and Mann-Whitney Test U-statistic values are included in the table and are used as the basis for evaluation of impairment. Bold-faced statistic values indicate significant (≥ critical magnitude at 0.05 significance) differences between means.

STATION #	MR01-1	MR01-2	MR01-3	MEAN	ST. DEV.	SCORE	MR02-1	MR02-2	MR02-3	MEAN	ST. DEV.	SCORE	t STATISTIC	U STATISTIC
	MILL RIVER (upstream)						MILL RIVER (downstream)							
HABITAT SCORE	123						119							
TAXA RICHNESS	20	16	16	17	2.30	NA	14	17	11	14	3.00	NA	1.38	7.0
CHIRONOMID RICHNESS	11	6	8	8.33	2.52	NA	5	7	3	5	2.00	NA	1.79	8.0
BIOTIC INDEX	5.21	4.75	5.20	5.05	0.26	NA	7.52	7.72	7.86	7.70	0.17	NA	**14.7**	**9.0**
EPT INDEX	3	4	3	3.00	1.00	NA	3	1	0	1.00	2.00	NA	1.55	8.0
EPT/CHIRONOMIDAE	2.46	4.92	3.17	3.52	1.27	NA	0.40	0.06	0.00	0.15	0.22	NA	**4.53**	**9.0**
SCRAPERS/FILTERERS	3.50	6.67	2.78	4.32	2.07	NA	2.22	2.00	0.22	1.48	1.10	NA	2.10	**9.0**
% DOMINANT TAXON	26%	36%	38%	0.33	0.06	NA	42%	39%	54%	0.45	0.08	NA	1.98*	0*
COMMUNITY SIMILARITY(CC) INDEX	1.0	1.0	1.0	1.00	0.00	NA	0.29 0.33 0.33	0.38 0.36 0.36	0.39 0.37 0.37	0.35	0.03	NA	**38.2**	**9.0**
TOTAL METRIC SCORE				NA						NA				
% COMPARABILITY TO REFERENCE STATION										NA				
BIOLOGICAL CONDITION-DEGREE IMPAIRMENT				**REFERENCE (upstream control)**						**SLIGHTLY IMPAIRED**				

* based on arcsine transformed values (not shown) which normalize the distribution of variates.

Table B4. Data matrices for ordination of similarities calculated from the coefficient of community (cc) index for macroinvertebrates on Hester-Dendy multiplate samplers. The cc index was compared both among triplicate samplers and between triplicate samplers for the MR01 and MR02 stations.

Data matrix1:

station	MR01-1	MR01-2	MR01-3	MR02-1	MR02-2	MR02-3
MR01-1	-	0.61	0.56	0.29	0.38	0.39
MR01-2		-	0.63	0.33	0.36	0.37
MR01-3			-	0.33	0.36	0.37
MR02-1				-	0.45	0.56
MR02-2					-	0.71
MR02-3						-

Data matrix 2:

station	MR01-1	MR01-2	MR01-3	MR02-1	MR02-2, MR02-3
MR01-1	-	0.61	0.56	0.29	.39
MR01-2		-	0.63	0.33	.37
MR01-3			-	0.33	.37
MR02-1				-	.51
MR02-2 MR02-3					-

Data matrix 3:

station	MR01-1	MR01-2, MR01-3	MR02-1	MR02-2, MR02-3
MR01-1	-	.59	0.29	.39
MR01-2		-	0.33	.37
MR01-3			0.33	.37
MR02-1			-	.51
MR02-2 MR02-3		-		

Data matrix 4:

station	MR01-1, MR01-2, MR01-3	MR02-1	MR02-2, MR02-3
MR01-1	-	.29	.39
MR01-2		.33	.37
MR01-3		.33	.37
MR02-1		-	.51
MR02-2 MR02-3	-		

Data matrix 5:

station	MR01-1, MR01-2, MR01-3	MR02-1	MR02-2, MR02-3
MR01-1	-	.34	
MR01-2		.35	
MR01-3		.35	
MR02-1	-		
MR02-2			
MR02-3			

Data matrix 6:

station	MR01-1	MR01-2, MR01-3, MR02-1, MR02-2, MR02-3
MR01-1	-	.34
MR01-2	-	
MR01-3		
MR02-1		
MR02-2		
MR02-3		

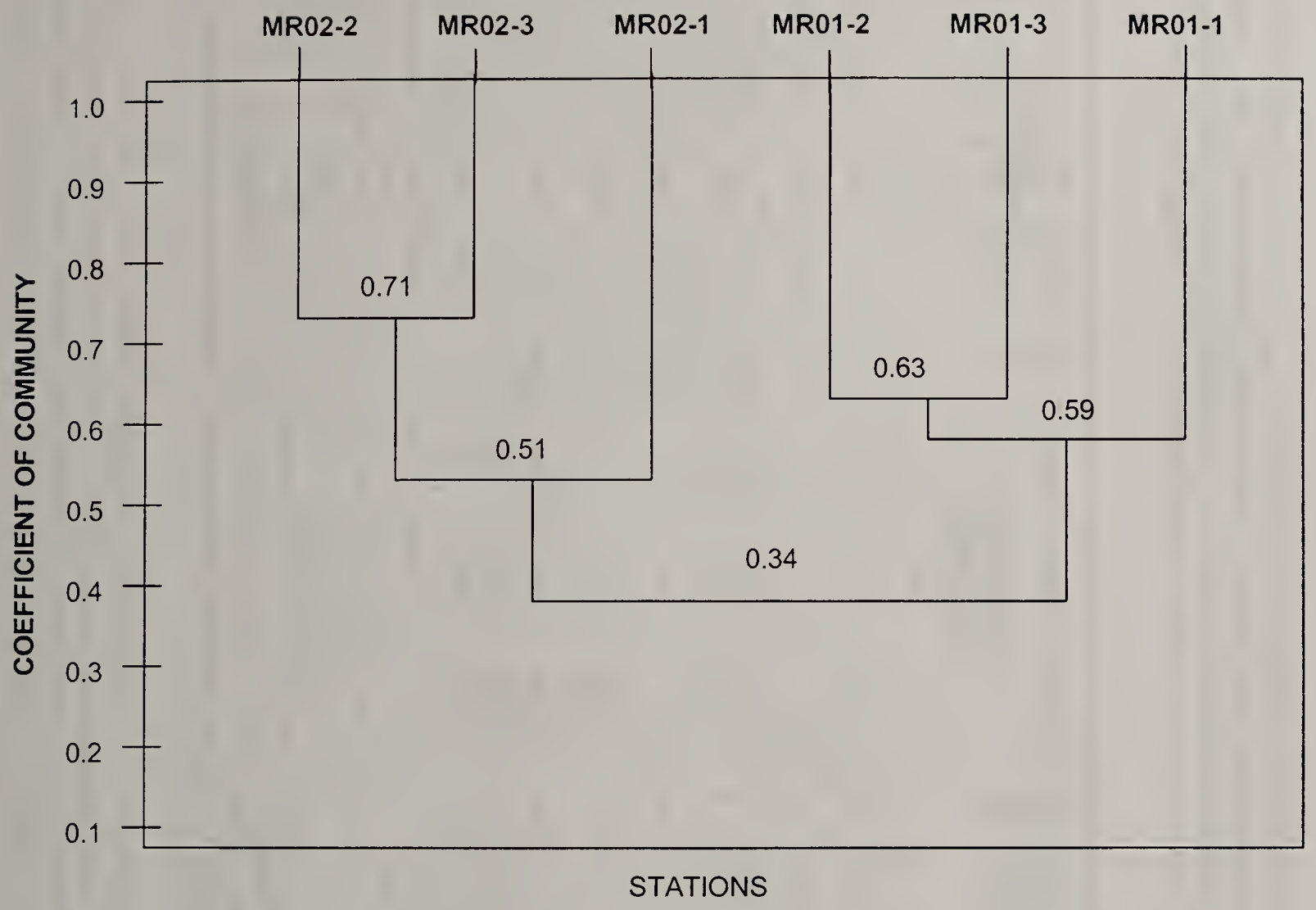

Figure B2. Ordination of community similarities for macroinvertebrates on Hester-Dendy multiplate samplers at Mill River.

Table B5. Summary of data analysis for macroinvertebrate communities sampled in the Charles River between 17 August and 24 September 1997. Nine biological metrics were calculated for taxa collected from each triplicate sample. Mean metric values for downstream samplers (reach 2) were compared to those for the upstream reference station (reach 1) using the Student's t-test and the Mann-Whitney Test. The t-statistic values and Mann-Whitney Test U-statistic values are included in the table and are used as the basis for evaluation of impairment. Bold-faced statistic values indicate significant (≥ critical magnitude at 0.05 significance) differences between means.

STATION #	SUB 1	SUB 2	SUB 3	MEAN	ST. DEV.	SCORE	SUB 1	SUB 2	SUB 3	MEAN	ST. DEV.	SCORE	t STATISTIC	U STATISTIC
	CHARLES RIVER (REACH 1)						CHARLES RIVER (REACH 2)							
HABITAT SCORE	65						66							
TAXA RICHNESS	18	20	21	19.7	1.53	NA	18	17	23	19.3	3.21	NA	0.20	5.50
CHIRONOMID RICHNESS	6	9	10	8.33	2.08	NA	8	7	7	7.33	0.58	NA	0.80	6.0
BIOTIC INDEX EPT INDEX	7.34 1.00	7.17 1.00	7.24 1.00	7.25 1.00	0.09 0.00	NA	6.76 1.00	6.36 1.00	6.97 2.00	6.97 1.33	0.31 0.67	NA	1.50 0.85	0.0
TOTAL ABUNDANCE	118	250	192	187	66.2	NA	129	145	179	151	25.5	NA	0.88	6.0
SHANNON DIVERSITY SHANNON EVENNESS	1.97 0.68	1.38 0.46	1.71 0.56	1.69 0.57	0.30 0.11	NA	1.89 0.64	2.07 0.72	2.04 0.64	2.00 0.67	0.10 0.05	NA	1.70 1.43	1.00 2.00
% DOMINANT TAXON	43%	65%	58%	0.55	0.11	NA	52%	30%	50%	0.44	0.12	NA	1.22*	7.0*
COMMUNITY SIMILARITY (CC) INDEX	1.00	1.00	1.00	1.00	0.00	NA	0.50 0.53 0.51	0.51 0.54 0.42	0.54 0.51 0.50	0.51	0.04	NA	**21.2**	**9.0**
TOTAL METRIC SCORE				NA						NA				
% COMPARABILITY TO REFERENCE STATION										NA				
BIOLOGICAL CONDITION-DEGREE IMPAIRMENT				**REFERENCE (upstream control)**						**NONIMPAIRED**				

* based on arcsine transformed values (not shown) which normalize the distribution of variates.

Table B6. Summary of data analysis for macroinvertebrate communities sampled in the Charles River between 17 August and 24 September 1997. Nine biological metrics were calculated for taxa collected from each triplicate sample. Mean metric values for downstream samplers (reach 3) were compared to those for the upstream reference station (reach 1) using the Student's t-test and the Mann-Whitney Test. The t-statistic values and Mann-Whitney Test U-statistic values are included in the table and are used as the basis for evaluation of impairment. Bold-faced statistic values indicate significant (≥ critical magnitude at 0.05 significance) differences between means.

STATION #	SUB 1	SUB 2	SUB 3	MEAN	ST. DEV.	SCORE	SUB 1	SUB 2	SUB 3	MEAN	ST. DEV.	SCORE	t STATISTIC	U STATISTIC
	CHARLES RIVER (REACH 1)						CHARLES RIVER (REACH 3)							
HABITAT SCORE	65						58							
TAXA RICHNESS	18	20	21	19.7	1.53	NA	24	17	21	20.7	3.51	NA	0.45	3.5
CHIRONOMID RICHNESS	6	9	10	8.33	2.08	NA	10	6	9	8.33	2.08	NA	0.00	4.5
BIOTIC INDEX EPT INDEX	7.34 1.00	7.17 1.00	7.24 1.00	7.25 1.00	0.09 0.00	NA	7.39 4.00	6.91 2.00	6.39 3.00	6.90 3.00	0.50 1.00	NA	1.19 **3.45**	6.0 0.0
TOTAL ABUNDANCE	118	250	192	187	66.2	NA	145	88	216	150	64.1	NA	0.70	6.0
SHANNON DIVERSITY SHANNON EVENNESS	1.97 0.68	1.38 0.46	1.71 0.56	1.69 0.57	0.30 0.11	NA	2.61 0.82	2.52 0.87	0.81 0.77	1.98 0.82	1.01 0.05	NA	0.48 **3.60**	3.0 0.0
% DOMINANT TAXON	43%	65%	58%	0.55	0.11	NA	21%	22%	22%	0.22	0.01	NA	**5.18***	**9.0***
COMMUNITY SIMILARITY (CC) INDEX	1.00	1.00	1.00	1.00	0.00	NA	0.62 0.59 0.53	0.40 0.54 0.53	0.36 0.49 0.52	0.51	0.08	NA	**10.6**	**9.0**
TOTAL METRIC SCORE				NA						NA				
% COMPARABILITY TO REFERENCE STATION										NA				
BIOLOGICAL CONDITION-DEGREE IMPAIRMENT				**REFERENCE (upstream control)**						**NONIMPAIRED**				

* based on arcsine transformed values (not shown) which normalize the distribution of variates.

Table B7. Summary of RBP III data analysis for macroinvertebrate communities sampled in the Charles River between 11 July and 3 September 1997. Seven biological metrics were calculated and scored (in italic) for taxa collected from each triplicate sample. Mean metric values were scored, totaled and compared to those for the upstream reference station (BB04). The percent comparability to the reference station yields a final impairment score for the study site. Due to non-replicated data (2 of 3 samplers lost) at CR05, t-tests were not performed and statistical comparisons between upstream and downstream metrics were not made.

STATION #	CR05-1	CR05-2 (lost)	CR05-3 (lost)	MEAN	St. Dev.	SCORE	CR06-1	CR06-2	CR06-3	MEAN	ST. DEV.	SCORE	t STATISTIC
	CHARLES RIVER (UPSTREAM)						CHARLES RIVER (DOWNSTREAM)						
HABITAT SCORE	113						131						
TAXA RICHNESS	15	-	-	NA	NA	6	19	12	20	17	NA	6	NA
BIOTIC INDEX	8.38	-	-	NA	NA	6	7.36	7.52	7.43	7.44	NA	6	NA
EPT INDEX	3	-	-	NA	NA	6	4	2	6	4.00	NA	6	NA
EPT/CHIRONOMIDAE	0.06	-	-	NA	NA	6	0.24	0.07	0.34	0.22	NA	6	NA
SCRAPERS/FILTERERS	0.43	-	-	NA	NA	6	2.60	0.22	0.33	1.05	NA	6	NA
% DOMINANT TAXON	37%	-	-	NA	NA	2	22%	31%	39%	31%	NA	2	NA
COMMUNITY SIMILARITY (CC) INDEX	1.00	-	-	NA	NA	6	0.65	0.59	0.57	0.60	NA	4	NA
TOTAL METRIC SCORE				38						36			
% COMPARABILITY TO REFERENCE STATION										95%			
BIOLOGICAL CONDITION-DEGREE IMPAIRMENT				**REFERENCE (upstream control)**						**NONIMPAIRED**			

Table B8. Summary of RBP III data analysis for macroinvertebrate communities sampled at tributary stations in the Charles River watershed between 8 July and 15 July 1997. Seven biological metrics were calculated and scored (in italic) for taxa collected at each station. Scores were then totaled and compared to an upstream reference station (SR01, SR02) and a regional reference station (ST01). The percent comparability to the reference station yields a final impairment score for each study site.

STATION #	SR01		SR02		SR03		SR02		SR03		ST01		SR01		SR02		SR03	
STREAM	Stop River		Stop River		Stop River		Stop River		Stop River		Stony Brook		Stop River		Stop River		Stop River	
HABITAT SCORE	159		177		129		177		129		155		159		177		129	
TAXA RICHNESS	26	*6*	10	*6*	10	*4*	10	*6*	19	*6*	30	*6*	26	*6*	10	*6*	19	*4*
BIOTIC INDEX	4.42	*6*	5.61	*4*	5.83	*4*	5.61	*6*	5.77	*6*	3.77	*6*	4.42	*6*	5.61	*2*	5.77	*2*
EPT INDEX	3	*6*	3	*6*	4	*6*	3	*6*	4	*6*	12	*6*	3	*2*	3	*0*	4	*0*
EPT/CHIRONOMIDAE	0.51	*6*	0.58	*6*	7.27	*6*	0.58	*6*	7.27	*6*	3.36	*6*	0.51	*6*	0.58	*6*	7.27	*6*
SCRAPERS/FILTERERS	0.03	*6*	0.14	*6*	0.03	*2*	0.14	*6*	0.03	*2*	0.20	*6*	0.09	*4*	0.14	*6*	0.03	*0*
% DOMINANT TAXON	13%	*6*	57%	*6*	48%	*6*	57%	*0*	48%	*6*	25%	*4*	13%	*6*	57%	*0*	48%	*0*
COMMUNITY SIMILARITY	100%	*6*	5%	*0*	17%	*0*	100%	*6*	18%	*0*	100%	*6*	20%	*0*	4%	*0*	18%	*0*
TOTAL METRIC SCORE		*42*		*16*		*16*		*36*		*26*		*40*		*24*		*8*		*12*
% COMPARABILITY TO REFERENCE STATION			38%		38%				72%				60%		20%		30%	
BIOLOGICAL CONDITION -DEGREE IMPAIRMENT	**Reference Station (upstream)**		**Moderate**		**Moderate**		**Reference Station (upstream)**		**Slight**		**Reference Station (regional)**		**Slight**		**Moderate/ Severe**		**Moderate**	

Table B9. Summary of RBP III data analysis for macroinvertebrate communities sampled at 3 mainstem stations in the Charles River watershed between 9 July and 11 July 1997. Seven biological metrics were calculated and scored (in italic) for taxa collected at each station. Scores were then totaled and compared to an upstream reference station (CR03, CR04). The percent comparability to the reference station yields a final impairment score for each study site.

STATION #	CR03		CR04		CR00			CR04		CR00	
STREAM	Charles River		Charles River		Charles River			Charles River		Charles River	
HABITAT SCORE	149		160		116			160		116	
TAXA RICHNESS	30	*6*	19	*4*	21	*4*		19	*6*	21	*6*
BIOTIC INDEX	3.77	*6*	6.54	*2*	5.44	*2*		6.54	*6*	5.44	*6*
EPT INDEX	12	*6*	6	*0*	6	*0*		6	*6*	6	*4*
EPT/CHIRONOMIDAE	3.36	*6*	2.05	*4*	2.38	*4*		2.05	*6*	2.38	*6*
SCRAPERS/FILTERERS	0.20	*6*	0.03	*0*	0.00	*0*		0.03	*6*	0.00	*6*
% DOMINANT TAXON	25%	*4*	27%	*4*	18%	*6*		27%	*2*	18%	*4*
COMMUNITY SIMILARITY	100%	*6*	21%	*0*	18%	*0*		100%	*6*	39%	*2*
TOTAL METRIC SCORE		*40*		*14*		*16*			*38*		*28*
% COMPARABILITY TO REFERENCE STATION			35%		40%					74%	
BIOLOGICAL CONDITION-DEGREE IMPAIRMENT	**Reference Station (upstream)**		**Moderate**		**Moderate**			**Reference Station (upstream)**		**Slight**	

Table B10. Summary of RBP III data analysis for macroinvertebrate communities sampled at eight tributary stations in the Charles River watershed between 8 July and 21 August 1997. Seven biological metrics were calculated and scored (in italics) for taxa collected at each station. Scores were then totaled and compared to the regional reference station (ST01). The percent comparability to the reference station yields a final impairment score for each study site.

STATION #	ST01		TB01		RB01		BE02		TB01		PB01		PB01		MB02	
STREAM	Stony Brook		Trout Brook		Rosemary Brook		Beaver Brook		Alder Brook		Fuller Brook		PowissettBrook		Mine Brook	
HABITAT SCORE	155		179		135		127		159		138		138		136	
TAXA RICHNESS	30	*6*	22	*4*	15	*2*	21	*4*	17	*2*	14	*2*	21	*4*	25	*6*
BIOTIC INDEX	3.77	*6*	4.81	*4*	5.66	*2*	5.62	*2*	5.38	*4*	5.00	*4*	3.58	*6*	4.90	*4*
EPT INDEX	12	*6*	7	*0*	2	*0*	2	*0*	2	*0*	2	*0*	6	*0*	2	*0*
EPT/CHIRONOMIDAE	3.36	*6*	0.28	*0*	0.58	*0*	0.07	*0*	1.60	*2*	2.20	*4*	0.22	*0*	1.87	*4*
SCRAPERS/FILTERERS	0.20	*6*	0.48	*0*	0.00	*0*	4.90	*0*	0.21	*0*	0.06	*2*	0.15	*0*	0.97	*6*
% DOMINANT TAXON	25%	*4*	40%	*0*	36%	*2*	44%	*0*	26%	*4*	41%	*0*	40%	*2*	18%	*6*
COMMUNITY SIMILARITY	100%	*6*	20%	*0*	14%	*0*	9%	*0*	20%	*0*	12%	*0*	15%	*0*	34%	*2*
TOTAL METRIC SCORE		*40*		*14*		*10*		*10*		*18*		*10*		*18*		*28*
% COMPARABILITY TOREFERENCE STATION			35%		35%		35%		45%		35%		45%		70%	
BIOLOGICAL CONDITION-DEGREE IMPAIRMENT	**Reference Station (regional)**		**Moderate**		Moderate		**Moderate**		**Moderate**		**Moderate**		**Moderate**		**Slight**	

Appendix C (1997Charles River Watershed Biological Monitoring)

Habitat, Fish Population, and Periphyton Population Data Collected During the 1997 Charles River Watershed Survey

Table C1. Habitat assessment summary for the 25 macroinvertebrate stations sampled during the 1997 Charles River watershed survey. For those primary parameters, scores ranging from 16-20 =optimal; 11-15 =suboptimal; 6-10 =marginal; 0-5 =poor. For those secondary parameters, scores ranging from 9-10 =optimal; 6-8 =suboptimal; 3-5 =marginal; 0-2 =poor.

STATION	CR03	CR04	CR03	SR01	SR02	SR03	ST01	TB01	BB04	BE02	BB04	FB02	CB01	MR02	BB04	BB04A	MR01	MR02	CR06	CR06	CB01	DP01	JB01	WB01	RM01
PRIMARY HABITAT PARAMETER (range is 0-20)																									
Instream Cover	4	16	10	18	19	1	15	17	9	9	11	18	1	13	1	18	18	8	9	16	1	4	7	16	1
Epifaunal Substrate	19	19	19	18	17	9	18	20	18	11	18	15	9	15	1	2	9	2	17	15	10	2	7	15	3
Embeddedness	16	15	17	15	17	9	18	18	18	18	18	17	18	13	NA	NA	9	2	1	7	9	NA	NA	16	18
Channel Alteration	19	18	17	17	15	15	18	19	15	18	18	18	20	17	18	20	15	18	20	20	7	20	7	19	20
Sediment Deposition	18	18	13	18	18	1	13	18	18	18	18	18	18	18	1	18	9	18	18	14	9	9	9	18	15
Velocity-Depth Combinations	10	11	19	8	16	11	10	14	7	8	8	18	8	10	8	4	7	7	16	15	11	7	8	8	1
Channel Flow Status	15	18	9	18	17	18	15	17	15	9	18	15	13	17	18	15	18	20	18	16	9	2	1	18	5
SECONDARY HABITAT PARAMETERS (RANGE IS 0-10) FOR EACH BANK																									
Bank Vegetative Protection	9 9	10 10	9 9	10 10	10 10	8 10	9 9	9 9	9 9	10 9	9 9	9 9	10 10	7 10	10 10	10 10	10 10	10 10	10 10	10 10	1 1	10 10	8 10	7 10	10 10
Bank Stability	8 9	10 8	9 9	10 10	10 10	9 10	9 9	9 9	8 7	10 9	9 10	9 9	10 10	9 10	10 10	10 10	10 10	10 10	9 9	10 4	7 7	8 9	9 9	9 10	9 10
Riparian Vegetative Zone Width	2 8	5 10	2 8	10 10	8 10	10 9	10 10	9 10	9 3	9 3	10 10	1 1	10 8	1 10	10 8	10 10	10 10	10 2	10 10	10 10	1 1	10 10	1 9	5 10	9 10
Total Score	119	159	119	159	177	119	159	119	136	127	159	136	136	136	119	136	119	119	119	131	63	86	74	151	121

Table C2. Fish population and density data collected by DWM at 5 biomonitoring stations in the Charles River watershed on 24 July 1997. Sampling stations were at: Stony Brook (ST01), Trout Brook (TB01), Rosemary Brook (RB01), Powissett Brook (PB01), and Alder Brook (AB01).

TAXA	ST01	TB01	RB01	PB01	AB01
American Eel (*Anguilla rostrata*)			5		
Brown Trout (*Salmo trutta*)	1				
Brown Bullhead (*Ameiurus nebulosus*)					5
Eastern Brook Trout (*Salvelinus fontinalis*)	4	49			
Chain Pickerel (*Esox niger*)				2	
Largemouth Bass (*Micropterus salmoides*)			4		2
Pumpkinseed (*Lepomis gibbosus*)					21
Redfin Pickerel (*Esox americanus americanus*)	11	33			
White Sucker (*Catostomis commersoni*)		2	1		
Yellow Bullhead (*Ameiurus natalis*)					2

Table C3. Periphyton population and abundance data collected by DWM at biomonitoring stations in the Charles River watershed between 15 July and 6 August 1997.

Stream name	Date	Location	Habitat	Algal Genera	Algal Group	Abundance
TRIBUTARIES						
Fuller Brook	16-Jul-97	upst. fr. Dover St., Wellesley	riffle	*Spirogyra*	green	abundant
				Closterium	green	rare
				Cymbella	diatoms	rare
				undet pennate	diatoms	sparse
				Tabellaria	diatoms	rare
				Meridion	diatoms	rare
				Melosira	diatoms	common
				Synedra	diatoms	sparse
				Stigeoclonium	green	rare
Stony Brook	6-Aug-97	ST01	riffle	organic floc		rare
		at Viles St., Weston		*Synedra*	diatoms	rare
				Surirella	diatoms	rare
Cheesecake Brook	16-Jul-97	CB01 at Nevada St, Newton	run	*Melosira*	diatoms	common
				Scenedesmus	green	common
				Chlamydomonas	green	abundant
				Ulothrix	green	sparse
				Pleodorina	green	rare
Trout Brook	16-Jul-97	TB01 upst. fr. Haven St., Dover	riffle	*undet coccoid green*	green	abundant
Beaver Brook	17-Jul-97	BE02 dnst. fr. Trapelo Rd., Belmont/Waltham	riffle, cobble	*Spirogyra*	green	abundant
				Melosira	diatoms	common
Rosemary Brook	16-Jul-97	RB01 dnst. fr. Barton St. Wellesley	riffle, cobble	*Melosira*	diatoms	abundant
				Closterium	green	sparse
				Sphaerocystis	green	sparse
				Stigeoclonium	green	sparse
Rosemary Brook	16-Jul-97	RB01 dnst. fr. Barton St. Wellesley	riffle	*Spirogyra*	green	abundant
				Ulothrix	green	abundant
Fuller Brook	16-Jul-97	FB02 upst. fr. Cameron St. Wellesley	run	*Spirogyra*	green	abundant
				Melosira varians	diatoms	abundant
				sewage fungus	bacteria	sparse
Stop River	15-Jul-97	SR03 dnst. fr. Noon Hill Av., Medfield	riffle	*Melosira*	diatoms	abundant
				Navicula	diatoms	abundant
				udet pennate	diatoms	abundant
				Fragilaria	diatoms	common
				Lyngbya	blue-green	sparse
				Cocconeis	diatoms	sparse
				Synedra	diatoms	sparse
				Scenedesmus	green	sparse
				Pediastrum	green	sparse

Table C3. Periphyton population and abundance data collected by DWM at biomonitoring stations in the Charles River watershed between 15 July and 6 August 1997 (continued).

Stream name	Date	Location	Habitat	Algal Genera	Algal Group	Abundance
MAINSTEM						
Charles River	15-Jul-97	CR01A California St., Watertown	riffle	*Melosira* *Spirogyra* *Rhizoclonium* *Ulothrix*	diatoms green green green	abundant abundant sparse sparse
Charles River	15-Jul-97	CR01A California St. at the Watertown Dam, Watertown	pool	*Spirogyra* *Melosira* *Cymbella*	green diatoms diatoms	very abundant common sparse
Charles River	15-Jul-97	CR04 at Dean St./Turner St., Millis	run	*Rhizoclonium* *Spirogyra* *Melosira*	green green diatoms	abundant sparse sparse
Charles River	15-Jul-97	CR03 dnst. fr. Walker St. Medway	riffle, cobble	*Spirogyra*	green	very abundant
Charles River	15-Jul-97	CR04 at Dean St./Turner St., Millis	riffle, cobble	*Closterium* *Melosira* *Aphanizomenon* *Spirogyra* *Synedra* *Pediastrum* sewage fungus	green diatoms blue-green green diatoms green bacteria	rare sparse sparse common abundant sparse common
Charles River	15-Jul-97	CR04 at Dean St./Turner St., Millis		*Oscillatoria* *Sphaerocystis* *Scenedesmus* *Nostoc* *Microcystis*	blue-green blue-green green blue-green blue-green	 sparse sparse sparse sparse

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APPENDIX D – CURRENT ACTIVITIES, CHARLES RIVER WATERSHED

Appendix D contains four summary tables of ongoing studies in the Charles River Watershed. These tables include: Water Quality Sampling, Assessment Projects, Water Supply Activities and Other Charles Basin Activities. Shading in the following tables indicates those activities taking place over the timeframe of the CSO Variance which are expected to provide information to assist DEP and EPA in making a final determination on the appropriate level of CSO control in the Charles Basin.

Water Quality Sampling

Proponent/Study	Scope	Product/Timeframe	Contact	Comments
CRWA Water Quality Monitoring	Monthly water quality monitoring at 37 sites throughout the length of the river. Periodic sampling of tributaries and hotspots.	continuous	Kathy Baskin (617) 965-5975	Volunteer Water Quality Monitoring
CRWA/EPA Water Quality Monitoringand Notification Project	Bacterial testing of Lower Basin is used to project whether water quality is suitable for boating. Real-time info is presented to the public through flagging, internet, and newspapers.	March 1998 - Dec. 1999 final data report	Kathy Baskin (617) 965-5975	Funded by EPA - Part of EMPACT Project.
DEP Water Quality Survey	sampling of 47 stations including mainstem and tribs from the upper basin up to the Watertown Dam.	May '97 - May '98	John Fiorentino (508) 767-2862	Year 2 Basin activity, Final Report Feb 2000.
EPACharles River Water Quality Baseline Study	Baseline water quality monitoring of River from Watertown Dam to New Charles River Dam to evaluate progressof CSO and stormwater control activities	July '98 thru year 2005	Peter Nolan (781) 860-4343	1998 Sampling Report issued Aug. 1999
MWRA CSO Receiving WaterMonitoring	Wet and dry weather sampling of 14 sites in the Lower Basin to measure the effect of CSO's on the Charles River. MWRA is also conducting virus studies at Cottage Farm, Stony Brook, and CAM 005 and; Nutrient studies at the Watertown Dam and the Science Museum.	May '98 - Dec. '98	Andrea Rex (617) 242-0230	Sampling plan developed annually
DEP/CRWA Stormwater Sampling Grant	104b grant awarded to DEP to sample stormwater outfalls in multiple river basins, including the Charles Basin.	May'99 – June 2000	Tom Mahin (978) 661-7660	4-5 locations/3-4 storm events, one event sampled, six locations
USGS Sediment Study	Determine spatial extent of salt-water wedge in lower Charles Basin. Determine sediment quality in detail at proposed "swimmimg" areas. Evaluate sediment pollutant fluxes		Rob Breault (508) 480-5061	
CRWA Charles River Modeling	104b grant issued to CRWA to develop HSPF water quality model for the CharlesRiver Basin.	Final Report Jun-99	Kathy Baskin (617) 965-5975	Modeling will be coordinated IM3 study
EPA EMPACT Study	Perform enhanced monitoring for fecal coliform and enterococcus in recreational areas in the lower Charles Basin and BostonHarbor. Field test new methods for measuring enterococcus and evaluate the use of PCR testing to quantify pathogens.	1998 – 1999	Matt Liebman (617) 565-3590	1998 EMPACT report issued in May 1999

Assessment Projects

Proponent/Study	Scope	Product/Timeframe	Contact	Comments
USGS w/EOEA/EPA/MWRA Stormwater and Mainstem Loads in the Lower Charles Basin	Multiparty project headed by USGS to determine stormwater flows and loads in the Lower Charles Basin and estimate water quality improvements through implementation of stormwater BMPs.	Oct. '98 - June 2001	Gene Parker (508) 490-5026	Interim Report will be issued to coincide with CSO Variance Sampling Program and Model Development underway
DEP Charles Basin Assessment	Assessment of water quality and pollutant sources in the Charles Basin.	December '98	Rick McVoy (508) 767-2877	Final Charles River Watershed 1997/1998 Water Quality Assessment Report issued Feb 2000
CRWA Integrated Monitoring, Modeling, & Management Project (IM3)	Comprehensive study of entire watershed involving water quality, flow monitoring, watershed and groundwater monitoring, and development of a management plan.	1994 - 1999	Kathy Baskin (617) 965-5975	Final Phase II Report issued Feb 1999
ACOE Lower Basin Feasibility Project	ACOE is planning feasibility study with MDC as local sponsor. Study will evaluate restoration of lower basin aerators.	?	Barbara Blumeris (978) 318-8737	Scope of study being developed
CRWA Urban Stormwater Remediation Project	Assessment of efficiency of stormwater BMPs on the BU Campus - projected water quality improvements and costs.	1998 - 2001	Kathy Baskin (617) 965-5975	Baseline monitoring completed, BMPs to be constructed soon
CRWA Stormwater Standards Performance Analysis	104b grant awarded to CRWA to evaluate the effectiveness of the recently issued stormwater policy and performance standards.	1998 –June2000	Pam DiBona (617) 965-5975	Work includes sampling pre and post BMPs
MWRA Variance Activities	As a condition of the CSO variance, MWRA must conduct additional analyses on Cottage Farm performance and storage options, further I/I work, and further in-system controls to reduce CSO discharges.	10/98 - 10/2000	Mike Hornbrook (617) 242-0230	CSO monitoring, I/I elements completed Stormwater assessments ongoing
BWSC Stony Brook Sewer System Study	Study evaluated a range of potential improvements to the Stony Brook sewer system. Included field investigation of overflow conduits, brooks, regulators, and interceptors.	Final Report 8/97	John Sullivan (617) 439-3028	BWSC proceeding with design and construction with sewer separation in Stony Brook area
DEP/CRWA Watershed Permitting Project	104b grant to fund demonstration project to establish watershed permitting in a small subwatershed in the Charles Basin (Stop River watershed).	1999 - ?	Bob Zimmerman (617) 965-5975	Project is now focused on ground water resources in the upper Charles basin.
CRWA/MDC Charles Assessment Modeling	MDC-funded CRWA project to utilize models developed during USGS stormwater study to evaluate stormwater management altematives throughout the Charles Basin.	1999 - ?	Kathy Baskin (617) 965-5975	Project will expand USGS work on a basin-wide level.
USGS/DEM/DEP/CRWA Upper Charles Simulation/Optimization Model	Development of groundwater model in the upper charles basin. Evaluation of groundwater management alternatives.	10/98 - 1/2000	Leslie DeSimone (508) 490-5023	Field work on going.
Fenway Alliance Restoration and Action Plan - Muddy River	guide to flood mitigation and restoration of the Muddy River from Jamaica Pond to the Charles River	final report 11/97		Recommends extensive dredging, infrastructure improvement, and river restoration projects
ACOE Muddy River Feasibility Study	Investigation of water quality and related environmental problems in the Muddy River watershed. Aeration/Flow augmentation recommended in Final Plan.	draft report 7/98	Dick Heiderbercht (978) 318-8513	Initial recommendation is for $6.7 million in restoration projects. ACOE also now scrutinizing Phase I dredging program(based on ENF) to identify opportunities for ACOE participation.

Water Supply Activities

Proponent/Study	Scope	Product/Timeframe	Contact	Comments
DEP Upper Basin Technical Assistance	104b grant to develop guidance on sustaining groundwater water supply sources in Franklin, Norfolk, and Millis.	final guidance 11/98	Tara Gallagher (617)292-5930	
CRWA ANP Mitigation Project	To offset water consumption, American National Power is providing $1.2 million to fund multi-task water conservation and aquifer recharge projects in the towns of Bellingham and Blackstone.	groundwater model leak detection septic system rehab	Kathy Baskin (617) 965-5975	Project to begin after proponents procure necessary permits.
USGS Cambridge Watershed Study	Assessment of pollutant sources to the Hobbs and Stoney Brook reservoirs focusing on sodium also includes nutrients/iron/manganese assessment. Includes significant land use and stormwater evaluations	10/97 - 9/99	Chris Waldron (508) 480-5049	

Other Charles Basin Activities

Proponent/Study	Scope	Product/Timeframe	Contact	Comments
MWRA/CSO Program	Disinfection process facilities will be upgraded at the Cottage Farm CSO Treatment Plant and dechlorination facilities will also be constructed Separation of Stony Brook combined sewer system. Hydraulic Relief at CAM 005 and floatables controls at all CSO outfalls.	Cottage Farm work to be complete 3/99	Mike Hornbrook (617) 242-0230	Separation work, hydraulic relief will be constructed in accordance with Court Schedule
MDC Lower Basin Masterplan	Assessment of the land uses and parklands along the lower Charles from Watertown Square to Science Park	final report 12/98	Julia O'Brien (617) 727-9693	land use issues
MDC Upper Basin Land Restoration	ISTEA funds provided to MDC to restore land area along the Upper Charles. Project included construction in 90+ areas of encroachment and included swales and other stormwater management structures.	project complete Oct-98	Julia O'Brien (617) 727-9693	
MDC Charles River Dam Improvements	Construction and repair of low and high sluice gates at the new dam.	construction completion Dec-98	Carney Terzian (617) 727-5264	Project should mitigate salt water intrusion into basin and improve flushing in the basin.
EPA/RMI Daylighting Project	Project to open or "daylight" existing segment of stream, which is currently culverted.	Report on recommended site due ?	Jay Brolin (617) 565-9453	Project only funded through planning stage
Lower Basin Communties	Aggressive illicit connection removal and stormwater management initiatives are continuing in the lower ten communities in the Charles basin.	continuous	Jay Brolin (617) 565-9453 Kevin Brander (978) 661-7770	
CRWA/CLF Environmental Zoning Project	Project involves CLF and CRWA working with the Town of Holliston to develop zoning strategies to preserve and protect water resources	Through 8/2000	Kathy Baskin (617) 965-5975	Plan will go before town meeting for endorsement in Spring 2000